出國報告（出國類別：其他）

參加經濟合作暨發展組織核能署(OECD/NEA)舉辦第十六屆核設施除役工作小組(WPDD)會議

服務機關：行政院原子能委員會
放射性物料管理局
姓名職稱：鄭維申組長

派赴國家：法國巴黎
出國期間：104 年 11 月 21 日至 11 月 27 日
報告日期：104 年 12 月 31 日

摘 要

核能設施除役與拆除工作小組(Working Party on Decommissioning and Dismantling，簡稱 WPDD) 屬於經濟合作暨發展組織(Organization for Economic Co-operation and Development, 簡稱 OECD)的核能署(Nuclear Energy Agency, NEA)專業委員會下的工作小組，成立於 2001 年。主要目的為探討核能設施除役與拆除有關之政策、策略、法規、財務、除役技術、土地復育及除役廢棄物管理等議題，以促進國際間在核設施除役與放射性廢棄物管理之國際合作。目前參與之國家有美、英、法等 21 國，以及國際原子能總署(IAEA)與歐盟執委會(EC)二個國際組織。WPDD 每年召開一次會議，會議地點除在 NEA 巴黎總部，此工作小組會議原則上每隔二年由各會員國輪流舉辦。

有關核設施除役資訊及技術之國際交流，除了 WPDD 以外，NEA 早於 1985 年即成立核設施除役合作計畫(Co-operative Programme for the Exchange of Scientific and Technical Information Concerning Nuclear Installation Decommissioning Projects，簡稱 CPD)，提供各國在推動執行核設施除役計畫有關之研究發展、執行及經驗回饋等資訊交流平台。我國核能研究所於 2004 年 1 月以台灣研究用核反應器(TRR)之除役計畫，以中華台北名義加入；台電公司歷經多年的努力爭取，於 2014 年 7 月獲所有 CPD 會員國同意，並於當年 8 月 27 日以核一廠之除役計畫成為 CPD 之會員。

我國核能一廠自 1978 年 12 月運轉迄今已邁入 37 年，依現行核子反應器設施管制法之規定，台電公司已於今(2015)年 12 月提出除役計畫，向原能會申請除役許可，目前已受理審查。為擴大核設施除役國際經驗的交流與技術分享，我國積極爭取參加 NEA/WPDD 會議。經多方努力，於 2014 年 6 月獲 NEA 來函邀請我方派員出席 10 月在俄羅斯莫斯科舉行之第十五屆會議，並於會中簡報我國管制機關核設施除役規劃與管制準備。今年再次受邀為第二年參與 WPDD 會議，我方代表團為原能會物管局鄭維申組長、核研所魏聰揚主任及台電公司核能發電處簡福添處長及核能後端處丁宇組長參加。會議中由魏主任報告我國核能研究所除役與除污技術發展，台電公司報告核能一廠除役規劃兩項簡報，深獲美國能源部、英國及瑞典等代表的熱烈討論。我國藉由參與此工作小組會議，除可與 WPDD 所有會員國進行除役技術交流，共享各國所累積的除役經驗，提昇我國核設施除役作業之安全與效率外，將可成為我國未來加入另一個國際組織邁進重要一步。

目　次

壹、目的 (含緣起)

1961 年國際間為促進經濟合作發展議題，在法國巴黎成立經濟合作暨發展組織(Organization for Economic Co-operation and Development, 簡稱 OECD)。另因為經濟發展過程需要能源協助，其中核能的應用亦屬能源的一環，為此 OECD 將 1958 年在巴黎成立的歐洲核能署(European Nuclear Energy Agency, ENEA)納入其組織，1972 年因日本加入該組織後，改名為核能署 NEA。截至 2015 年 11 月，NEA 共有 31 個會員國，主要來自歐洲、北美洲及亞太地區。這 31 個國家的核電裝置約佔全球 86%以上，平均提供這些國家約 2 成左右的電力供應。

NEA 的主要任務為提供各會員國在核能和平應用有關之安全、經濟與環保等議題之技術與經驗交流合作，現有職員 82 人，其中除少數專職人力外，大部由各會員國派員支援，2013 年的預算約 1,110 萬歐元，是由各會員國認捐而來。NEA 設有核能指導委員會(Steering Committee for Nuclear Energy)，為最高決策單位，由各會員國代表組成，並依工作性質設立核設施安全、核能管制、放射性廢棄物管理、輻射防護與公眾健康、核子科學、核能發展與燃料循環技術及經濟研究、核能法規等七個專業委員會。

核能設施除役與拆除工作小組(Working Party on Decommissioning and Dismantling，簡稱 WPDD) 屬於經濟合作暨發展組織(Organization for Economic Co-operation and Development, 簡稱 OECD)的核能署(Nuclear Energy Agency, NEA)專業委員會下的工作小組，成立於 2001 年。主要目的為探討核能設施除役與拆除有關之政策、策略、法規、財務、除役技術、土地復育及除役廢棄物管理等議題，以促進國際間在核設施除役與放射性廢棄物管理之國際合作。目前參與之國家有美、英、法等 21 國，以及國際原子能總署(IAEA)與歐盟執委會(EC)二個國際組織。WPDD 每年召開一次會議，會議地點除在 NEA 巴黎總部，此工作小組會議原則上每隔二年由各會員國輪流舉辦。

WPDD 成立 16 年來，有許多工作成果。包括：對於核能設施及除役時所產生的廢金屬回收再使用、除役設施的核種特性調查研究、各會員國除役工作經驗交流、除役設施經費之估算、核能設施運轉期間與停機後對除役工作的準備、及除役後設施土地再利用的研究等，均分由各個工作組進行研究。另外每年均設定有一主題研究，協助會員國針對除役工作需要，互相研究探討。

有關核設施除役資訊及技術之國際交流，除了 WPDD 以外，NEA 早於 1985 年即成立核設施除役合作計畫(Co-operative Programme for the Exchange of Scientific and Technical Information Concerning Nuclear Installation Decommissioning Projects，簡稱 CPD)，提供各國在推動執行核設施除役計畫有關之研究發展、執行及經驗回饋等資訊交流平台。我國核能研究所於 2004 年 1 月以台灣研究用核反應器(TRR)之除役計畫，以中華台北名義加入；台電公司歷經多年的努力爭取，於 2014 年 7 月獲所有 CPD 會員國同意，並於當年 8 月 27 日以核一廠之除役計畫成為 CPD 之會員。

我國核能一廠自 1978 年 12 月運轉迄今已邁入 37 年，依現行核子反應器設施管制法

之規定，台電公司已於今(2015)年 12 月提出除役計畫，向原能會申請除役許可，目前已受理審查。為擴大核設施除役國際經驗的交流與技術分享，我國積極爭取參加 NEA/WPDD 會議。經多方努力，於 2014 年 6 月獲 NEA 來函邀請我方派員出席在俄羅斯莫斯科舉行之第十五屆會議，並於會中簡報我國管制機關核設施除役規劃與管制準備。今年再次受邀為第二年參與 WPDD 會議，我方代表團為原能會物管局鄭維申組長、核研所魏聰揚主任及台電公司核能發電處簡福添處長及核能後端處丁宇組長，另原能會派駐 OECD 代表侯榮輝技正及林繼統技正參加。會議中由魏主任報告我國核能研究所除役與除污技術發展，台電公司報告核能一廠除役規劃兩項簡報，深獲美國能源部、英國及瑞典等代表的熱烈討論。我國藉由參與此工作小組會議，除可與 WPDD 所有會員國進行除役技術交流，共享各國所累積的除役經驗，提昇我國核設施除役作業之安全與效率外，將可為我國未來加入 WPDD 正式會員邁進重要一步。

貳、 過程

一、行程概要

日期	地點與行程	工作內容
11 月 21 日（六）	台北-維也納-法國	去程
11 月 23 日（一）	法國巴黎	參加 OECD/NEA 舉辦之第十六屆核設施除役工作小組會議 WPDD-16
11 月 24 日（二）	法國巴黎	參加 OECD/NEA 舉辦之第十六屆核設施除役工作小組會議 WPDD-16
11 月 25 日（三）	法國巴黎	參加 OECD/NEA 舉辦之第十六屆核設施除役工作小組會議 WPDD-16
11 月 26 日（四）	法國巴黎	參加 OECD/NEA 舉辦之第 34 屆核設施除役工作小組會議 CPD
11 月 27 日（五）	法國巴黎	參加 OECD/NEA 舉辦之第 34 屆核設施除役工作小組會議 CPD
11 月 28 日（六）	巴黎-台北	返程

二、第 16 屆 WPDD 會議議程

23 November 2015 (Day 1)　　　Chairperson: Juan Luis SANTIAGO

14:00	**1.**	**OPENING THE MEETING** *Juan-Luis SANTIAGO, Spain, WPDD Chair*		
14:15	**2.**	**REVIEW AND ADOPTION OF AGENDA** *Juan-Luis SANTIAGO*	**D**	*(Document No.1)*
14:20	**3.**	**REVIEW AND APPROVAL OF SUMMARY RECORD OF WPDD-15 (2014)** *Juan-Luis SANTIAGO*	**D**	*(Document No.2)*
	4.	**DEVELOPMENTS AND ACTIVITIES WITHIN THE NEA**		
14:25	***4.a***	**RWMC and NEA Steering Committee** *Michael SIEMANN, Head of Division RPRWM*	**I**	Oral Report
14:40	***4.b***	**CPD** *Ivo TRIPPUTI, Italy, CPD Management Board Chair*	**I**	Oral Report
	5.	**PROGRAMME OF WORK OF THE WPDD**		
14:55	***5.a***	**Decommissioning Cost Estimation Group (DCEG)** *Simon CARROLL, Sweden, DCEG Chair* DCEG-8 Meeting Achievements and Current Status of Work Discussion	**I**	Oral Report
15:25	***5.b***	**Task Group on Radiological Characterisation and Decommissioning (TGRCD)** *Arne LARSSON, Sweden, TGRCD Chair* Achievements and Current Status of Work Extension of the Mandate Discussion	**I** **D**	Oral Report
15:55	***BREAK***			
16:10	***5.c***	**Task Group on Nuclear Site Restoration (TGNSR)** *Peter ORR, UK, TGNSR Chair* *Presentation and Discussion of the fi33nal DRAFT report* Outlook on future topics of work *(The Report on "Strategic Considerations for the Sustainable Remediation of Nuclear Installations during Decommissioning" will be circulated to WPDD members prior to the meeting for comments. A procedure for approval-in-principle through the WPDD Bureau is proposed.)*	**I** **D**	*(Document No.4)*
16:40	***5.d***	**Task Group on Preparing for Decommissioning under Operation and after Final Shutdown (TGPFD)** *Inge WEBER on behalf of Gérard LAURENT, France, TGPFD Chair* *Terms of Reference* Current Status of Work *Discussion*	**I**	Oral Report
	6.	**MANAGEMENT OF LOW ACTIVITY RADIOACTIVE WASTE AND MATERIALS FROM DECOMMISSIONING**		
17:10	***6.a***	**Review of WPDD-15 Topical Session** *Fredrik DE LA GARDIE, Sweden*	**I**	Oral Report

	6.b	**Proposal for establishing the Task Group on Optimising Low Radioactive Waste and Materials Management** *Fredrik DE LA GARDIE, Sweden* Programme of Work/Terms of Reference	**I**	Oral Report
17:30	**6.c**	**Discussion** *Led by Chair*	**D**	
17:50	**7.**	**SUMMARY OF DAY 1**		
18:00	***ADJOURN***			

24 November 2015 (Day 2)

TOPICAL SESSION on 'Extended and Deferred Decommissioning'		
Session Chair: Anna CLARK, UK Rapporteur: Simon CARROLL, Sweden		
09:00	**TS1.**	**OPENING OF THE TOPICAL SESSION** *Anna CLARK, Session Chair*
09:10	**TS2.**	**Immediate vs. Deferred dismantling – Pre-analysis against post-problems+ WENRA (Report March 2015, referencing the IAEA safety guidelines)** *Vladimir MICHAL, IAEA (presentation 15', discussion 5')*
09:30	**TS3.**	**Technical Issues of Characterisation and Implication of Decay** *N.N. (presentation 15', discussion 5')*
09:50	**TS4.**	**Decommissioning Strategy in Vandellos (Spain)** *Juan Luis SANTIAGO, Enresa, Spain (presentation 15', discussion 5')*
10:10	**TS5.**	**Challenges in Deferred Decommissioning** *Paul HUNT, Magnox Ltd., UK (presentation 15', discussion 5')*
10:30	***BREAK***	
10:45	**TS6.**	**Asset Management and Reducing Asset Burden (Extended Decommissioning)** *Andy SZILAGYI, DOE, USA [tbc] (presentation 15', discussion 5')*
11:05	**TS7.**	**Changing the Decommissioning Strategy – Pros and Cons by examples of EDF** *Gérard LAURENT, EDF, France (presentation 15', discussion 5')*
11:25	**TS8.**	**Waste Disposal Routes – COVRA Intermediate Storage (The Netherlands)** *Jan BOELEN, COVRA, The Netherlands (presentation 15', discussion 5')*
11:45	**TS9.**	**Pros and Cons of Deferred vs. Prompt Decommissioning Approaches – A Discussion of Views (Panel Discussion at Waste Management Conference (March 2015))** *Rateb (Boby) ABU-EID, NRC, USA* *(presentation 25')*
12:10	**TS10.**	**PANEL**

12:45	**TS11.**	**CONCLUDING REMARKS** *Session Chair*		
13:00	***CLOSURE OF THE TOPICAL SESSION***			

TOPICAL SESSION 2 on 'THE FUTURE OF WPDD' ***This session for WPDD members only***				
Session Chair: Simon CARROLL, Sweden Rapporteur: Peter ORR, UK				
14:30	**8.a**	**OPENING OF THE TOPICAL SESSION** *Simon CARROLL, Session Chair*		
14:40	**8.b**	**RWMC STRATEGIC PLAN 2017-2022** *Michael SIEMANN, Head of Division RPRWM*	**I**	**Oral Report**
15:10	**8.c**	**Invited Presentation: Decommissioning Challenges and International Collaboration in the Offshore Oil or Gas Industry** *Nigel JENKINS, UK (presentation 20' + discussion 20')*	**I**	**Oral Report**
	8.d	**Overview on Past Activities of WPDD** *Inge WEBER, NEA Secretariat*	**I**	**Oral Report**
	8.e	**Discussion of future topics for and future structure of WPDD** *Workshop in small groups* *Members of the WPDD are asked to address their ideas, expectations and topics of interest.* *Delegates unable to be present at the meeting are invited to submit their ideas and expectations to the NEA Secretariat at the latest by 20th November 2015.* *Work in small groups (1 leader/rapporteur per group) + Discussions in the plenary* **Note from the Secretariat** The purpose of this discussion is to gather (1) views from delegates about the decommissioning needs in the member countries and (2) ideas about possible future areas of focus of WPDD after 2016. The aim is to identify key themes which may be incorporated in the RWMC Strategic Plan which constitutes the basis for the future work of WPDD.	**R**	***(Document No.3) WPDD Background Note***
	8.f	**Conclusion** *Session Chair*	R	
17:50	**9.**	**SUMMARY OF DAY 2** *Juan Luis SANTIAGO, WPDD Chair*		
18:00	***ADJOURN***			

25 November 2015 (Day 3)

09:00	**10.**	**OPENING OF DAY 3** *Juan Luis SANTIAGO, WPDD Chair*		
09:05	**4.**	**DEVELOPMENTS AND ACTIVITIES WITHIN THE NEA (cont'd)**		
	4.c	**NEA Expert Group on Fukushima Waste Management and Decommissioning** *Hiroomi AOKI, NEA Secretariat*	**I**	Oral Report
	4.d	**NEA Expert Group on Pre-disposal Management of Radioactive Waste (PMRW)** *Gloria KWONG, NEA Secretariat*	**I**	Oral Report

	4.e	**NEA Expert Group on Preservation of Records, Knowledge and Memory across Generations (RK&M)** *Pierre-Henri DE LA CODRE, NEA Secretariat*	**I**	Oral Report
	4.f	**NEA RepMet Expert Group** *Massimo CIAMBRELLA, NEA Secretariat*	**I**	Oral Report
09:35	**11.**	**NEW INITIATIVES**		
	11.a	**Graphite Management** *Vladimir LEBEDEV, NEA Secretariat* *(presentation 10' + discussion 5')*	**I**	Oral Report
	11.b	**NEA Working Group on Radiological Protection Aspects in Decommissioning (WGDECOM)** *Erwin NEUKÄTER, Switzerland* *(presentation 15' + discussion 15')*	**I**	Oral Report
	12.	**INTERNATIONAL DEVELOPMENTS**		
10:20	***12.a***	**EC – Decommissioning-related activities over the past year** *N.N., EC [tbc]*	**I**	Oral Report
10:30	***12.b***	**IAEA – Decommissioning-related activities over the past year** *Vladimir MICHAL, IAEA*	**I**	Oral Report
10:40	***BREAK***			
	13.	**COUNTRY UPDATES ON DECOMMISSIONING**		
11:00	***13.a***	**Invited Presentation: Update from Chinese Taipei on their preparations for Decommissioning of NPPs in Chinese Taipei** *Fu-Tien CHIEN, Taiwan Power Company, Chinese Taipei* *(presentation 15')*	**I**	Oral Report
11:15	**13.b**	**Country Updates on Decommissioning** *Country delegations, present and non present at the meeting, are invited to submit information on recent developments in their country on decommissioning aspects, following the structure of the template for individual country updates. The completed template should be provided to the NEA Secretariat at least one week before the meeting for later distribution.* *Delegations are asked to highlight max. four key points from the update on one overhead to summarise these developments for presentation at the meeting (5' for each delegation).*	**I**	Oral Reports
CLOSING SESSION				
12:15	**14.**	**WPDD GOVERNANCE** *Juan Luis SANTIAGO, WPDD Chair*		
	14.a	**Bureau Composition (former Core Group)** *Inge WEBER, NEA Secretariat*	**I**	Oral Report
	14.b	**Nomination of New Bureau Members** *Candidates:* Bernd REHS, BfS, Germany *Fredrik DE LA GARDIE, SKB, Sweden* Peter ORR, Environment Agency, UK N.N., France	**D**	Oral Report

	14.c	**Date and Place of Next Meetings** *The Secretariat proposes [tbd] to host the WPDD-17 in 2016.* *Proposed date: week of 14-18 Nov 2016* *WPDD-18 in 2017: NEA Offices, Paris, France* *WPDD-19 in 2018: proposed host country: Sweden [tbc]*	**D**	
12:30	**15.**	**ANY OTHER BUSINESS** *Juan-Luis SANTIAGO, WPDD Chair* *Any other item raised in the meeting that needs further addressing*	**I**	
12:45	**16.**	**REVIEW OF MAIN DECISIONS AND ACTION ITEMS** *Juan-Luis SANTIAGO, WPDD Chair*	**D**	
13:00		***ADJOURN***		

Joint Special Session on **Decommissioning Scene in Far East Asia**		
Session Chairs: Juan Luis SANTIAGO, WPDD Chair, Ivo TRIPPUTI, CPD Chair **Rapporteur: Fredrik DE LA GARDIE, Sweden**		
14:30	**JS1.**	**INTRODUCTION TO THE JOINT SPECIAL SESSION** *Session Chairs*
14:40	**JS2.**	**Overview of Decommissioning Issues in East Asia** *Vladimir MICHAL, IAEA* *(presentation 15', discussion 5')*
15:00	**JS3.**	**Experience in Preparation for Decommissioning in South Korea** *Sangmyeon AHN, KINS, Republic of Korea* *(presentation 15', discussion 5')*
15:20	**JS4.**	**Experience in Preparation for Decommissioning: Chinese Taipei** *Tsong-Yang WEI, INER, Chinese Taipei* *(presentation 15', discussion 5')*
15:40	***BREAK***	
16:00	**JS5.**	**Overview of responsibilities in Japan** *Yukihiro IGUCHI, JAEA, Japan* *(presentation 15', discussion 5')*
16:20	**JS6.**	**Challenges for the Experience Transfer for Preparing for Decommissioning within a Company** *Mitsuo TACHIBANA, JAEA, Japan* *(presentation 15', discussion 5')*
16:40	**JS7.**	**Waste Management Infrastructure (short, middle and long-term view) in Japan** *Hiroaki TAKAHASHI,NRA, Japan* *(presentation 15', discussion 5')*
17:00	**JS8.**	**Challenges in Decommissioning of Premature / Unplanned Shutdown Nuclear Power Plants – Experience from Expert Group on Fukushima Waste Management and Decommissioning** *Hiroomi AOKI, NEA Secretariat* *(presentation 15', discussion 5')*
17:20	**JS9.**	**DISCUSSIONS**
17:50	**JS10.**	**CONCLUDING REMARKS** *Session Chairs*
CLOSURE OF THE Joint Special Session		
18:00	***ADJOURN***	

參、心得

在OECD/NEA的組織架構中，最高層級為核能指導委員會，第二層級為各個專業委員會，例如放射性廢棄物管理委員會(RWMC)，第三層級為專業委員會下設之工作小組，例如除役與拆除工作小組(WPDD)，第四層級為工作小組下之任務小組，例如WPDD下設有除役成本估算任務小组(DCEG)、輻射特性與除役任務小組(TGRCD)、核設施場址復原任務小組(TGNSR)及運轉中與停機後核設施除役準備任務小組(TGPFD)。截至2015年10月，參與WPDD之會員國共有21個OECD會員與觀察員，分別為比利時、加拿大、捷克、芬蘭、法國、德國、匈牙利、義大利、日本、南韓、荷蘭、挪威、波蘭、羅馬尼亞、俄羅斯、斯諾伐克、西班牙、瑞典、英國、美國等；2個國際組織為國際原子能總署(IAEA)與歐盟執委會(EC)。

WPDD自2001年成立以來，每年召開一次年會，會議地點除固定在NEA巴黎總部外，隔年會由各會員國輪流舉辦。以往曾分別在俄羅斯（2014年）、英國（2012年）、美國（2010年）、斯諾伐克（2008年）、英國（2007年）、比利時（2005年）、西班牙（2003年）、德國(2002年)等國舉辦。本屆為例行性會議於巴黎NEA總部舉行，參與WPDD會議之代表，主要來自各國之管制機關、政府機構、核設施經營者、電力公司及研發單位等。除我國外，計有波蘭、捷克、斯諾伐克、俄羅斯、美國、瑞士、荷蘭、芬蘭、德國、法國、義大利、日本、韓國、挪威、西班牙、瑞典及英國等國近40人出席，IAEA及NEA派6人參加，總計與會人士超過50餘名。

本屆會議的議程安排，依WPDD會議原則，分有NEA發展與活動說明、經常性業務報告、特定議題討論、核設施除役管理專題—延長除役或暫緩拆除工作，WPDD未來發展與作業包括新的技術議題、國際的發展、各國年度資訊更新，WPDD工作會議、受邀出席國家與單位之專題報告等部分。

第一天會議首先由WPDD主席西班牙籍的SANTIAGO先生(西班牙ENRESA公司除役部門主管)致歡迎詞，並確認第15屆的會議決議。接著由NEA的RPRWM組長Michael Siemann進行經常性業務報告及CPD主席報告最近一年之活動與成效。IAEA代表報告最近一年所辦理與核設施除役有關之活動與成效、NEA代表報告RWMC最近一年之重要活動、成效與未來重點工作。接著由四個任務小組包括除役成本估算、核設施場址復育、輻射特性與除役作業及除役與拆除作業之研究發展，分別報告最近一年之活動、成效與未來工作規劃。

第二天上午討論核設施延長除役與延遲拆除(Extended and Deferred Decommissioning)的議題，先由IAEA代表提出立即拆除與延後拆除方案比較--先進行分析或待問題出現再處理優劣性比較報告。再分別由英國、法國、荷蘭代表共提出三篇報告，包括延後拆除的挑戰、法國改變除役策略緣由說明、荷蘭放射性廢棄物集中長期貯存策略等。

第三天上午探討各項主題的討論，包括我國台電公司受邀論文，說明核一廠除役之

準備(報告內容如附件一)，隨後由各國補充說明該國過去一年來，在核設施除役及拆除作業管理有關的更新資訊(如附件二)，並介紹WPDD新委員及明年會議預定於11月14~18日在義大利舉行。下午的特定議題為遠東地區核能設施除役狀況，分別由韓國、我國核研所及日本等代表提出報告。會議中魏主任報告我國核能研究所除役與化學除污技術發展(報告內容如附件三)，因技術性質較高且有一定成果，深獲美國能源部、英國及瑞典等代表的熱烈討論。我國藉由參與此工作小組會議，除可與WPDD所有會員國進行除役技術交流，分享各國所累積的除役經驗，提昇我國核設施除役作業之安全與效率外，將可成為我國未來加入WPDD邁進重要一步。

圖一、二 WPDD-16 我國代表團及會議剪影

以下摘述第十六屆WPDD會議較重要的討論內容，包括各工作小組報告、核設施延長除役及延遲拆除及遠東地區核能設施除役情形。

一、各工作小組報告

CPD主席報告，CPD有66個研究計畫仍在進行中，參與團體有25個，計有14個國家與歐洲經濟體參加會員。目前最大工作在於研商過去研究成果的保存方式，工作組正探討利用新的伺服器或雲端硬體，在可確保安全的前題下，讓會員分享所累積的資訊。今年TAG58工作會議於5月18-22日在德國舉行，討論議題為核能設施除役作業安全認可程序。TAG59工作會議於10月12-16日在斯諾伐克舉行，討論議題為核能設施除役期間異常事件與意外事故案例分析。2016年5月及10月將在比利時與日本舉辦兩次會議。

除役成本估算任務小組報告今年工作成效，已完成一份除役經費評估與除役項目評定的導則建議 The Practice of Cost Estimation for Decommissioning of Nuclear Facilities，此報告係利用各國除役工作經驗所完成的經費預估，對不同類型核電廠、研究用反應器、燃料製造工廠等除役工作或除役策略進行分項評估，可提供核能國家未來除役經費估算參考。而目前正進行IAEA與OECD/NEA合作計畫，題目為除役工作尚無法確認的費用的評估。其主要範圍在於意外事件與風險評估，在準備和管理核設施除役成本估算作業時，

無法確認的費用包括“偶發性”和“不確定性”這兩個狀況。“偶發性” 係指所定義中的一個活動項目，針對該特定項目可能發生了潛在性的成本增加，當發生了成本增加現象，其原因主要是由於一些工作項目中出現新的問題所造成。然而，根據已完成之計畫統計，整體而言，發生“偶發性”狀況所增加成本的範圍，通常僅限於10~30%之間。而“不確定性”係指計畫管控未考慮的項目所導致的成本變化，如；匯率的波動、未預料到的通貨膨脹率，管制法規的改變、新技術或廢棄物處置途徑的可適用性等等。”不確定性”因素對計畫成本的影響可能遠比“偶發性”因素為大。已有許多不同的解決方法可用於處理”不確定性”問題，且每個國家亦可使用不同的工具組合，如數值模擬或情景分析等模式，來處理此類問題，此報告預計2016年底完成。

輻射特性與除役任務小組報告自2010年起，分兩階段進行建立核能設施除役輻射特性調查策略，第一階段已於2013年完成。隨後進行第二階段工作，目標為放射性廢棄物及物質最終狀況的分析。有11個國家參與研究，成員包括獨立驗證專家、除役作業團隊、管制單位、核設施營運業者、處置場營運業者、放射性廢棄物處理業者及特別顧問團等共同組成。其主要工作項目由研討不同法規、標準與導則著手。透過問卷與經由12個國家不同核設施除役的案例分析，嘗試分析與定義可行性策略與特性調查模式，預計將於WPDD-17會議進行成果簡報說明。(圖三，四)

圖三、四 除役設施輻射特性調查作業與分析

核設施場址復原任務小組報告研究進程，包括由除役計畫、污染調查、場址概念規劃、放射性廢棄物處理、風險評估、資訊管理及研究發展著手。並認為場址復原不能只靠地表清理或地下水的清潔標準來認定，另須考量 1.未來場址的使用，2.移走有害物質或控制有害物質風險的做法及 3.放射性廢棄物的處理等方面。目前有些國家規範採取定義解除管制標準或準則，而非採基本風險分析的做法，將有助於場址復原目標，使長期管控結果可符合管制標準，以達保護環境與人類健康的目的。此報告預定於2016第一季完成。

運轉中與停機後核設施除役準備任務小組是依據WPDD-15次會議成立，目前有25個團體與9個國家參與此任務小組，啟動會議已於今年3月4日舉行。第一次會議在6月底舉

行，之後每個月進行電話會議。進行工作包括1.審視國際間核設施除役相關工作的文件，2.比較各國除役管制規範差異性，3.比較各國對於除役許可的作業方式，4.闡述除役項目的範圍，5.其他延伸的議題等。成果報告預訂於WPDD-17會議簡報。

IAEA代表針對一年來在核設施除役相關活動進行說明，目前IAEA正致力於建立除役國際網路平台進行努力。主要目的為提供有關除役作業的經驗交流：提高對於建立除役計畫選擇策略的注意力與必要性；祈能集中多方面資源，加速世界各國對於除役工作的準備等。2015年的平台活動有：4月在美國舉辦除役設施及場址復原的安全評估訓練；5月在印尼辦理小型核設施的除役訓練；6月在愛沙尼亞辦理書蘇聯廢料處置場除役訓練；7月再法國舉辦核種特性量測、取樣及建物復原訓練；10月在中國辦理地區性訓練，課程為研究用反應器除役、放射性廢棄物處理與保健物理訓練；11月在德國參與除役與環境復育工具箱會議、除役產生可解除管制廢棄物訓練、在IAEA總部辦理除役作業管制者與業者年度論壇；12月辦理核設施除役案例討論會議等。2015並辦理第3次日本福島核災除役審視任務，協助審視處理汙染廢水；地下水入侵廠房的計測；移出用過核燃料及受損燃料作業；放射性廢棄物處理、貯存及核種鑑定等，另外在研究方面，協助人員訓練、核能安全文化及與民眾溝通等，希望借由國際組織的力量，協助日本早日完成福島核災的復原與後續受損核電廠的除役規劃。(圖五、六)

在技術報告發布方面，IAEA計有四本報告：研究用反應器除役費用評估 (Cost Estimation of Research Reactor Decommissioning, NW-T-2.4)、核設施意外事件後除役與場址清理的案例分析與經驗交換 (Experiences and Lessons Learned Worldwide in the Cleanup and Decommissioning of Nuclear Facilities in the Aftermath of Accidents, NW-T-2.7)、核設施燃料池的除役 (De- commissioning of Pools in Nuclear Facilities, NW-T-2.6)、殘存於快滋生反應爐中鈉鉀的處理 (Treatment of Residual Sodium and Sodium Potassium from Fast Reactors, TECDOC-1769)。


圖五、六　IAEA專家至日本福島核災電廠協助審視

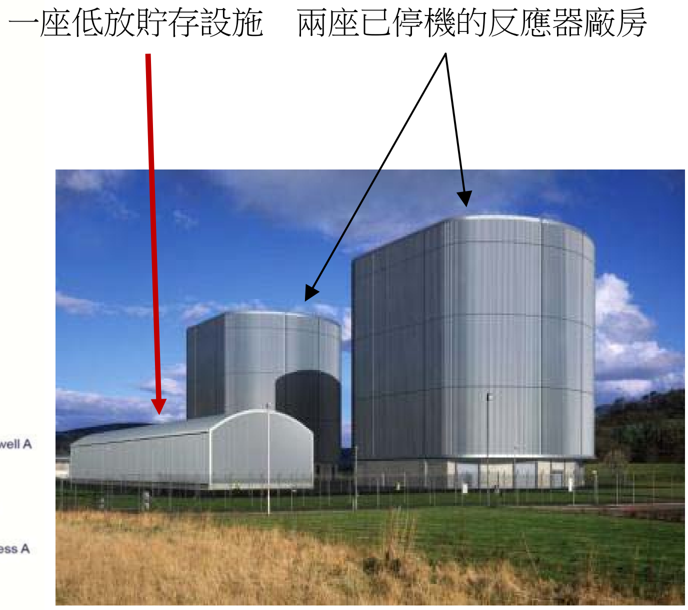
二、核設施延長除役及延遲拆除(Extended and Deferred Decommissioning)議題

國際間對核設施停止運轉後，基本上有三種管理策略立即除役、延遲拆除及固封。我

國、日本等採立即除役策略，美國、英國、俄羅斯則採延遲拆除策略，西班牙採混合策略(立即與延遲並列)。國際間已採固封的核設施，以曾發生嚴重核事故的車諾堡核電廠為代表。

延遲拆除的挑戰。由英國Magnox集團除役組組長Paul Hunt簡報目前在英國有12座核電廠計27組反應器，最後一座Magnox反應器將於2015年停機，這些反應器是以發包方式處理。計畫經費至2021年總列有40億英鎊，主要工作是將核電廠安全運轉到最後停機狀態。目前的目標訂於2028年，使12座核電廠均可達到安全停機(圖七)。在60年的期間，可確認機組穩定後，再進行拆除工作。並可利用這60年時間，發展出合適的除役技術與策略來完成除役工作。英國的延後拆除採取所謂的3 Box模式(圖八)，即是採用除役核設施內存在2座已停止運轉的反應器加上一座低放射性廢棄物貯存設施，並可能採取廠內處置的模式處理除役廢棄物。目前的挑戰在於，暫存60年階段期間，如何執行反應器的視察作業；場址復原清理的狀況；管制者與利害關係人的接受度；廠內蒸發器的防震安全；另要注意廠房防漏及廠內保安與保全問題等。採取延遲拆除策略時，應清楚定義各種狀況的解決與技術的累積，早期與管制者及利害關係人溝通，依實際安全風險評估結果，選定拆除設施，才可能達到延遲拆除的目標。

圖七 目前英國12座Magnox核電廠位置



圖八 3 Box的延遲拆除模式

英國採行延遲拆除的考量因素，主要是目前沒有高階放射性廢棄物或用過核燃料處置場，這些放射性廢棄物須要適當的地點進行長期安全貯存；延遲可以讓短半化期核種活度大幅降低，使後續拆除工作有更好的工法選擇且能更安全地進行；對一些由政府以公務預算籌措除役經費的核設施，延遲拆除可以讓政府有足夠的時間籌措除役相關經費。

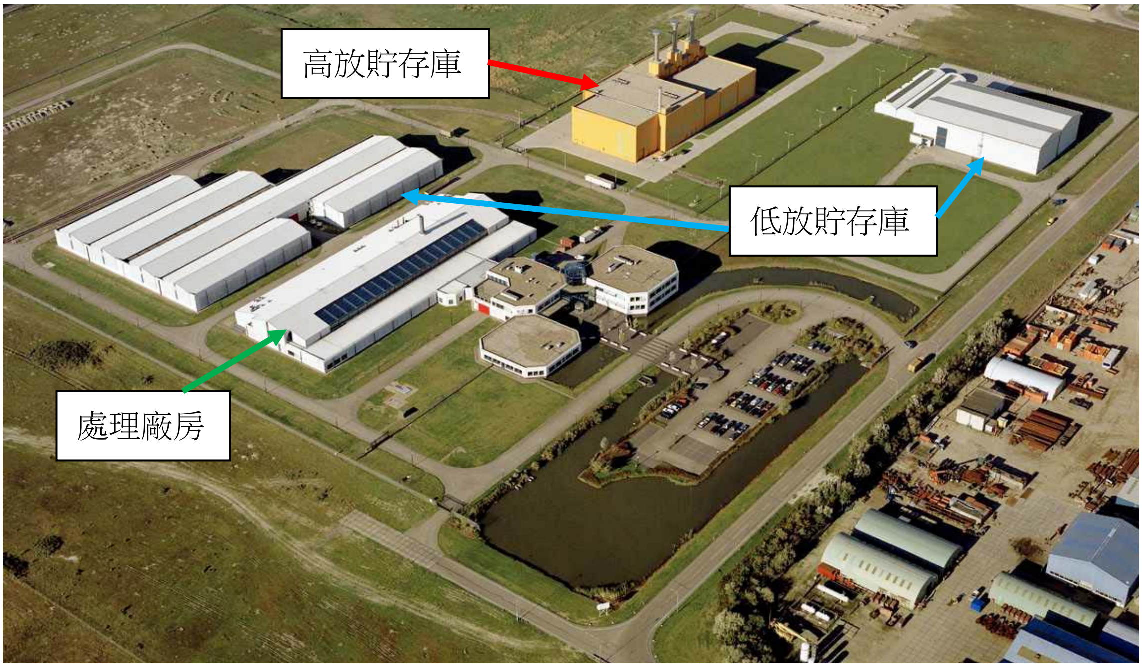
荷蘭COVRA集團Jan Boelen先生說明荷蘭對於放射性廢棄物的處理政策，在處置前

先採集中貯存的策略。荷蘭目前有一座500MWe核電廠運轉中、另一座已於1997年安全停機、有兩座研究用反應器、一座鈾濃縮廠及一座核燃料生產工廠。荷蘭在1984年政策已決定採地面集中貯存方式，至少先在人工建物內安全貯存100年，並須可隨時取出的狀況，等待國家最終處置場完成再行處置。荷蘭政府認為雖然在荷蘭核能發電規模並不大，且可能將要停止使用，但後續民間工業、研究或醫療所產生的放射性廢棄物並不會停止。因此在最終處置場完成前，要安全管理這些廢棄物最妥善的方式就是集中貯存，也可利用這段時間發展新的處理技術及處置新概念。

該國放射性廢棄物均由COVRA(Central Organization for Radioactive Waste)集團採集中貯存方式處理，1992年荷蘭在Borsele集中暫存低放廢棄物，1994年建立貯存庫，2003年建設高放射性廢棄物貯存設施，採自然冷卻方式，第一批再處理產生的高放射性廢棄物於2004年進廠。荷蘭的集中處貯存設施包括有廢棄物處理設施及減容設備，每座低放貯存設計容量為5000立方米，全廠區將規劃16座貯存庫，可存放包括核設施除役產生的所有放射性廢棄物。(圖九~十一)

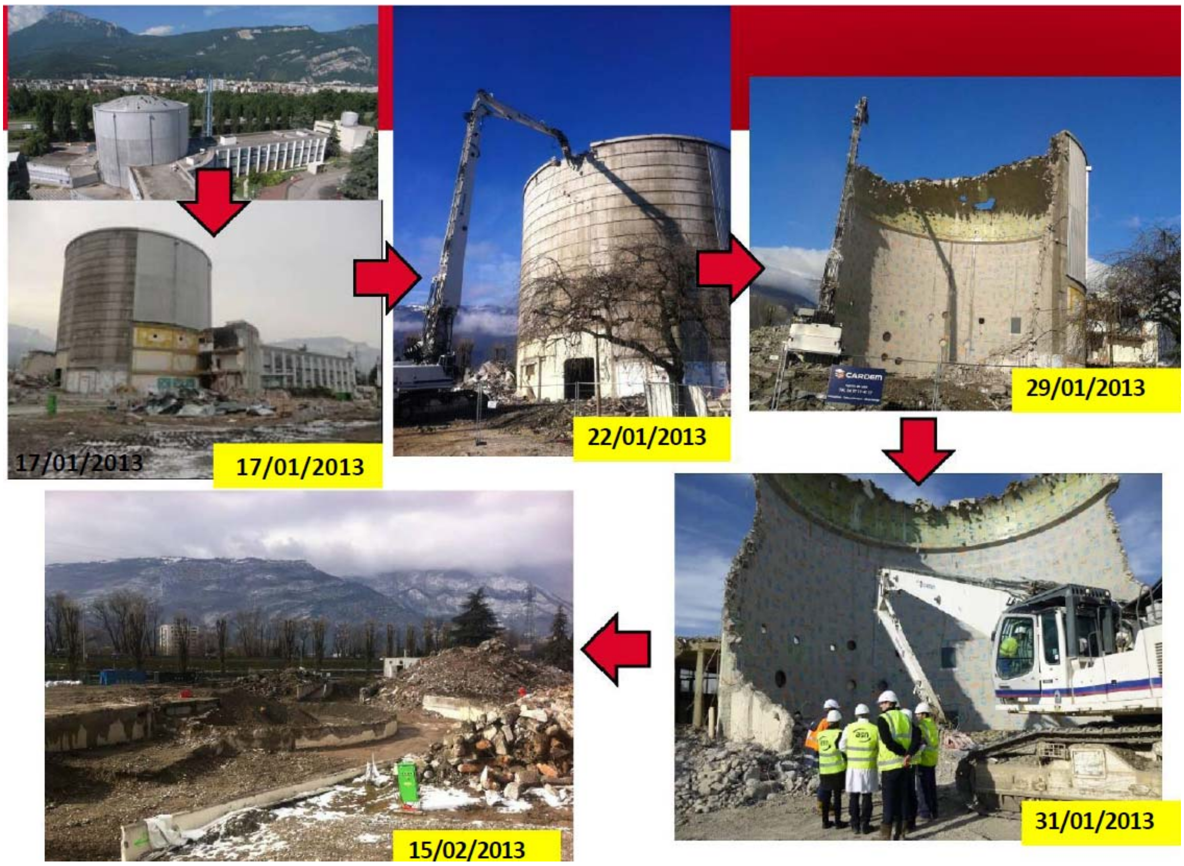
圖九　荷蘭低放廢棄物集中貯存庫

圖十　荷蘭高放廢棄物集中貯存庫



圖十一 荷蘭集中貯存設施場址

法國政府在2009年對於除役政策向業者提出建議，要採用立即除役的方案。2014年在頒布的能源轉換法條中宣示，核設施除役採用立即拆除已經確定。但對於業者的考量卻有所不同，CEA對於除役的目標訂在使設施安全停機，優先清理位於格勒諾布爾及豐特奈羅斯城鎮邊的核設施，並就除役經費與時程考量除役的速度。而策略則視現況立即且完全拆除核設施，如果無法完全清理場址的危險物質，則採限制性使用。由於法國的核能管制機關並未規定核設施完成除役的期限，但核設施經營者基於現有員工對設施配置及運轉情況最瞭解的考量下，多決定採儘速拆除的除役策略。簡報以Siloe核電廠為例，說明其於1963年運轉至1997年停機，在2005年開始拆除，到2015年完成除役。(圖十二)

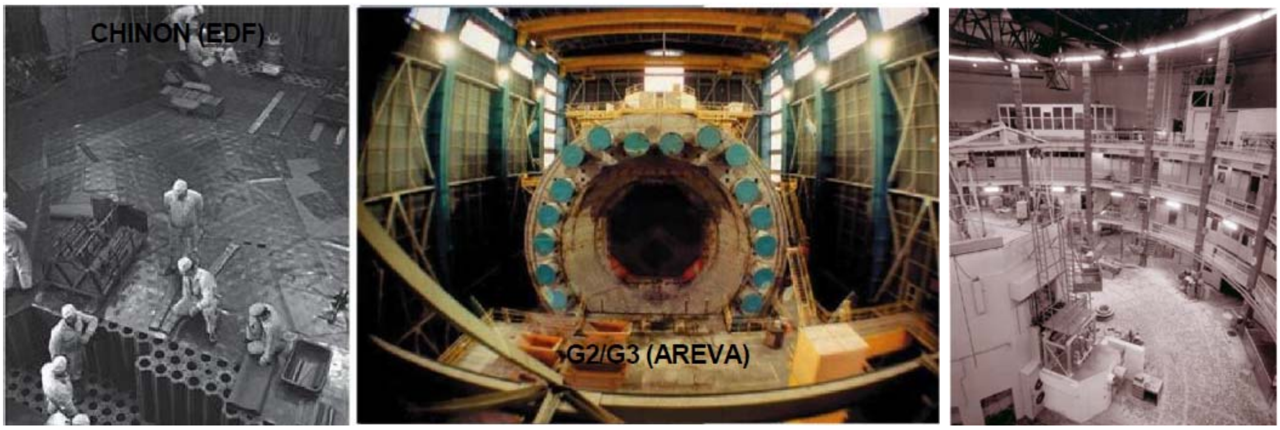


圖十二 Siloe核電廠圍阻體除役狀況

雖然法國並未採行延遲拆除的除役策略，但法國電力公司EDF經過國際相關議題分析，於本屆會議中報告因法國有石墨冷卻核電廠及重水爐，這些核設施除役將會產生23,000公噸的石墨放射性廢棄物，且這些石墨含有高濃度的碳14及氯36，無法處置在低放射性廢棄物處置場。依據法國負責處置的ANDRA公司表示目前並無石墨處置場存在，且在2025年之前也無法建立，因此對於這類設施CEA建議採行此類廢棄物暫放於核設施中，待處置場完成後再進行拆除。(圖十三)

為何法國政府在2000年改變他們對除役方式的看法？簡報中表示經過技術與經濟分析結果，立即除役與延遲拆除比較：延遲拆除可使鈷60活度降低，這理論十分簡單，但準確度並不高；因為反應器內的活度更高，且延遲拆除並沒得到好處；現在的除污技術

進步，一次側的除污因數已可達1000到5000，沒必要再等60年。延遲拆除對於存在廢棄物中長半化期的α及β核種量測並無幫助，但環境立法者可能會要求更多環境監測活動與輻射防護工作。延遲拆除可能有經驗傳承的問題，且會增加延遲拆除期間的維護費用。另外由第一代核設施除役經驗的累積，已建立維護與運轉及設計核電廠的經驗，有助於除役工作的規劃與進行；國際間類似核設施除役經驗，足以提供立即除役的技術；加上管制者的要求與IAEA的建議等因素,而使法國政府改變其原先除役策略而進行立即除役。



圖十三 石墨冷卻爐、快滋生反應器與重水爐將延遲除役

美國DOE及NRC兩位代表也對於美國所普遍採用延遲拆除的策略提出說明，在比較立即除役與延遲拆除在作業效益方面，美國的經驗顯示系統封存20年後，輻射劑量可降為原來的1/14，因此可大幅降低參與除役工作人員的輻射劑量。因為美國大部分核電廠為多機組的規模，各機組的運轉期限有所差異，並無法規劃同時進行拆除。依目前各國除役工作的進展，未來可能會有更先進的拆除技術，加上美國尚無用過核燃料或高放射性廢棄物的最終處置場，用過核燃料並沒有辦法移出廠外，僅能要求各核電廠進行廠內貯存。在經濟效益方面，延遲拆除有更長的期程讓民營公司來積存除役基金，可以紓解核電經營者的經濟壓力；延遲拆除可讓低放射性廢棄物因活度衰減，而降低必須處置放射性廢棄物的數量，減輕業者花費在處置的費用。最後，歸納美國核電廠進行長期安全封存的經驗，有幾點值得我們注意的事項，包括用過核燃料濕式貯存期間燃料池水的保存與淨化；清理受污染地區要注意防止污染擴散；封存對長半衰期核種的活度降低影響有限；良好的除役規劃取決於完整的廠址輻射特性調查；安全封存的期程常會因非預期的因素影響，而需配合調整。由以往核電廠除役的實務經驗顯示，選擇立即拆除作業考量的因素，在作業效益方面包括沿用現職工作人員對電廠系統較為瞭解，各系統或組件仍能維持較佳的運作狀況，除役時也能提供正確資訊，方便作業進行。在經濟效益方面可以在短期時間讓電廠土地資源充分再利用，降低經營者資金壓力。在風險管理方面，儘速除役可免除長期的責任負擔、有現成的核廢料處置場可以使用且能避免處置成本大幅波動、儘早動用以往累積提存的除役基金可降低未來除役成本增高的風險；在社會影響方面，儘早除役除了符合大多數民眾的期望，也能減輕來自管制機關的監管壓力。

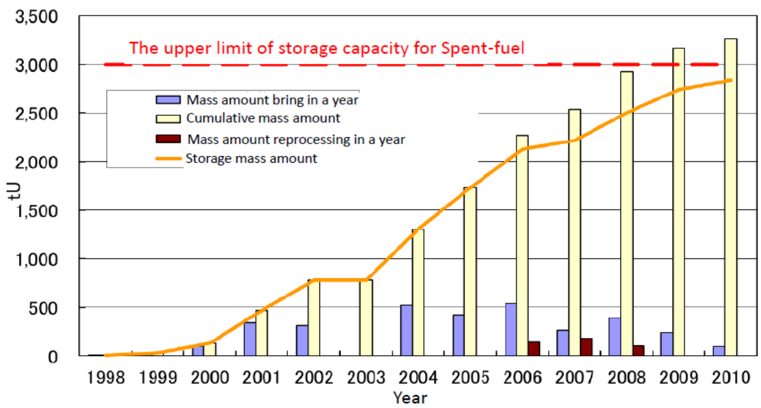
核電廠延遲拆除並非熄燈關門了事，而是要在法令許可的最長期限內，完成核設施

除役。其主要的考量在於安全封存期間，如何以最少的人力與經費，達成安全的目標。在進行安全封存前，需先規劃考量的事項包括盡可能清理管路中的輻射污染、清理無污染建物、污染區採清理或隔離方式、評估各系統或組件停止運轉、用過核燃料移除(乾、濕式；廠內、外貯存)、評估大型或被活化零組件的拆除等等。而有關停機封存所需的費用，以發生事故的三浬島二號機為例，其封存期間僅配置二位專職人力，大部份的監控、維修人力由繼續運轉的一號機調度支援，其所需費用每年約3~9仟萬新台幣。

三、遠東地區的核能設施除役情形

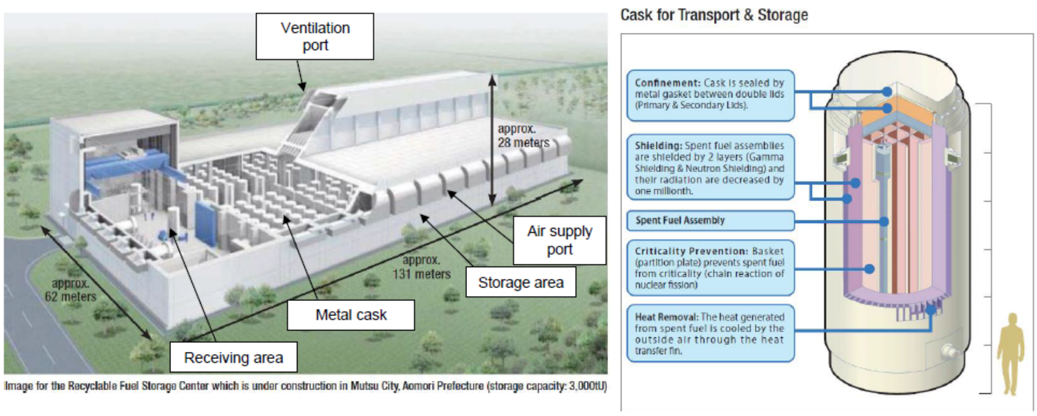
本次WPDD會議另一主要專題為遠東地區核設施除役情形，此次邀請我國核研所針對TRR除役的經驗與化學除污進行分享，並請日本報告核反應器的除役規劃與管制機關的要求，另由韓國報告核反應器除役準備狀況等簡報，讓歐美國家了解遠東地區的核設施除役情形，並透過此專題讓其他國家對遠東地區的核能運用與除役技術能更為清楚。

日本的放射性廢棄物處理方式與我國的規劃相近，差別是其用過核燃料採用再處理回收鈽及鈾再製為MOX燃料繼續使用於反應器，形成完整核燃料循環鏈。目前在青森縣六個所村有一座低放射性廢棄物處置場及再處理後高放射性玻璃固化體貯存中心；在茨城縣東海村有一座處置測試場；大洗町有一座放射性廢棄物集中貯存中心。在2009年其國內的用過核燃料水池貯存容量已不足應用(圖十四)，因此需採用乾式貯存方式，因應日益增加的用過核燃料。規劃中新的集中貯存空間將可存放288只金屬容器，共3000公噸用過核燃料(可增加到5000公噸)(圖十五)，至於高放射性廢棄物最終處置場址仍在尋覓中。



圖十四

日本用過核燃料貯存量統計



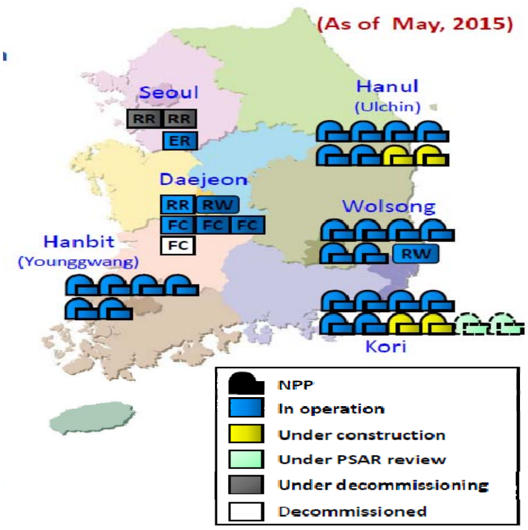
Source: Graphical Filp-chart of Nuclear & Energy Related Topics 2011 (http://www.fepc.or.jp/english/index.html)

圖十五　日本用過核燃料乾式貯存設計圖

在日本的除役規劃中，核設施營運業者在機組永久停機後，必須依核子反應器管制法提出除役計畫書，送日本核能管制機關審查。其計畫書主要內容包括：除役機組描述；依材質、放射性狀況的拆除方式、機具使用；用過核燃料、放射性物質處理與轉移(包括燃料使用歷史說明)；放射性廢棄物處置計畫，含用過核燃料、放射性物質的活度、種類及數量等；除役時間表，含人力配置、輻射曝露量、放射性廢棄物產生量、使用經費、財務保證等。並規定除役計畫中必須收集的四項資料，及部分資料必須透過計算模式加以評估，包括：1.物理量測資料：設施描述的圖形，含設備結構體積、重量、輻射管制區域及建物的面積等。2.放射活度偵測資料：機件及結構的放射活度、受汙染機具及結構的面積、水泥建物受汙染的深度與範圍、機具及結構的表面劑量率及空間劑量率等。3.除役管理資訊：工作人力、人員輻射曝露劑量估算、廢棄物產量及除役費用。4.安全分析資料：利用前面三項資訊計算對於公眾造成的輻射曝露劑量與影響。

日本原子力研究所認為準備核設施除役方面，仍存在一些困難度及不確定性資訊，包括：除役費用因風險評估及選擇除役方式的不確定性；設備組件運轉與使用的不確定性；要求必須收集的四項資料的困難度；機組設施圖形化因運轉設計變更或因除污需要而做的改變；運轉歷史資料顯示受汙染組件需有效選擇量測點或除污工作；缺乏核設施除役經驗資料庫等，均會在設施停止運轉除役前後造成困擾，有必要進一步研究。

南韓代表Sangmyeon Ahn簡報韓國準備核設施除役經驗，目前韓國核能相關設施有24座反應器運轉中，4部正在興建；有2部研究用反應器，另外2部正準備除役；2座核燃料工廠，分別生產核電廠及研究用反應器的燃料；另外有2座放射性廢棄物處理廠及1座低放射性廢棄物處置場。未來先除役的Kori一號機為壓水式反應器，容量587MW於1978年商轉，預定於2017年永久停機。(圖十六，十七)



圖十六　韓國核能設施分布圖

圖十七　2017年將停止運轉的KORI機組

為因應核電廠除役準備，在法規方面，2015年1月韓國為除役作業修訂核子安全法及相關規範，並將制訂除役技術標準與安全審查及檢查導則。韓國法規規定，除役計畫須併同興建許可與操作執照申請時提出，並必須每十年更新一次。其除役計畫內容須包括

組織架構、人員編制、除役經費來源與財務保證；除役策略、方式與時程；運轉中電廠除役準備與量測；移除放射性物質及除污方案；放射性廢棄物處理、貯存與處置；放射性物質對環境衝擊的評估；及其它主管機關要求事項。

南韓管制機關要求核設施營運者必須在永久停機後2~5年內提出除役申請，申請時業者須提出除役計畫書(初版)、品質保證計畫及民眾溝通紀錄。在管制者須確認除役報告書內容有匯總民眾對核設施除役的意見。另規定營運者除役期間需每半年需提出除役及組件拆除狀況說明，輻射管制狀況及放射性廢棄物處理狀況等工作結果。

韓國Kori電廠機組與我國核能一廠商轉時間相仿，在除役規劃方面的進度也相當接近，兩方營運者可互相觀摩與交換意見。

有關我國兩篇報告，台電公司主要說明核一廠基本運轉資訊、我國對於除役法規管制規定、除役規劃時程與時間表、核一廠廠區在除役時與除役後土地再使用的規劃說明、運轉期間所完成初步輻射特性調查結果、3D廠區結構說明與計畫中反應器解體的規劃等資訊，並針對核一廠放射性廢棄物的偵測結果與除役作業相關事項逐一說明。而核能研究所的簡報則針對台灣研究用反應器(TRR)的除役過程與廠房清理做一說明，同時也對因應TRR除役所研究應用的化學除污技術及解除管制作業與成效逐一說明，此部份詳細說明請見台電公司與核能研究所同時參加此會議之出國報告。

三天的會議最後由WPDD主席西班牙籍的SANTIAGO先生，綜合本次會議各項主題的討論結果做一總結，並暫訂明年會議的時間為2016年11月14~18日在義大利舉辦。

肆、建議

1. **參考國外除役策略考量，確認除役各階段工作。**我國的除役管制規定與國外並不相同，為求能在這一代負起責任處理完核設施，因此法規要求永久停止運轉後25年完成除役工作，另為能使營運者重視除役作業的重要性與管制者的審查準備，要求在永久停止運轉前三年必須提出除役計畫送審，在管制與責任，我國的設計是最為周延。為何國外不採行此法？以美國為例，因大部分業者均為民間公司，除役廢棄物產生多寡由業者自行負擔處置費用，除役時程長短，也是業者必須自行負責，因此美國核管會僅要求業者在核能電廠停機後，提交一份除役計畫，說明未來核設施如何除役，並不需送審。管制機關在業者完成除役後，才會進行審視場址復原狀況是否合乎要求。此管制方法屬結果論，與我國以國家體制的管制理念並不相同。

2. **開拓除役新技術，掌握商機。**除役工作最在意污染控制與工作人員劑量。善用機械工具進行遙控作業可以加速工作進行，並減少人員劑量。由於除役場地狹隘，必須使用輕巧機具，與一般工地見到的大型機具不同。建議國內有能力的工具廠商，儘早投入輕巧型拆除機具的設計、製造，並輔以電視監控與遙控功能，還有輻射環境偵測的自動化與遙測儀器，在未來核電廠除役會是相當大的市場。

3. **利用除役經驗，傳承未來發展。**核能設施的除役作業為近年來各國同時在努力開發的核能新技術，主要目的在於能安全停機、不使輻射汙染擴散、減少除役所產生的放射性廢棄物數量、場址復育的方法與模式等，莫不在求維護環境品質，保護人類健康。目前除役工作尚屬於初期工作，經由許多核設施除役經驗，除役工作會因環境不同需要邊做邊修正，以求最佳方案。其實除役工作首重於廠區輻射特性調查，這些偵測技術早就成熟，並沒有太多新技術或知識需開發，國內核一廠已按時程提出除役計畫，以我國法規規定，採用立即除役的模式，將會使我國的除役經驗居於除役工作的領頭地位。依目前各國核設施運轉狀況，當我們除役完成之時，接著將會是全球核設施除役高峰，若國內將來參與核電廠除役業者能好好把握參與除役經驗與技術開發，未來在拓展除役工業方面，將會是另一番新的事業。

4. 我國台電公司已依法規規定提出核能一廠除役計畫，若在運轉執照到期前，未能取得延長運轉執照申請，將會依除役計畫進行除役作業。屆時的實際作業與工作經驗將成為國際核設施除役重要的參考經驗，因此，按部就班完成除役工作與經驗傳承，將可在各國際組織間形成不小的影響力，各單位須密切注意。

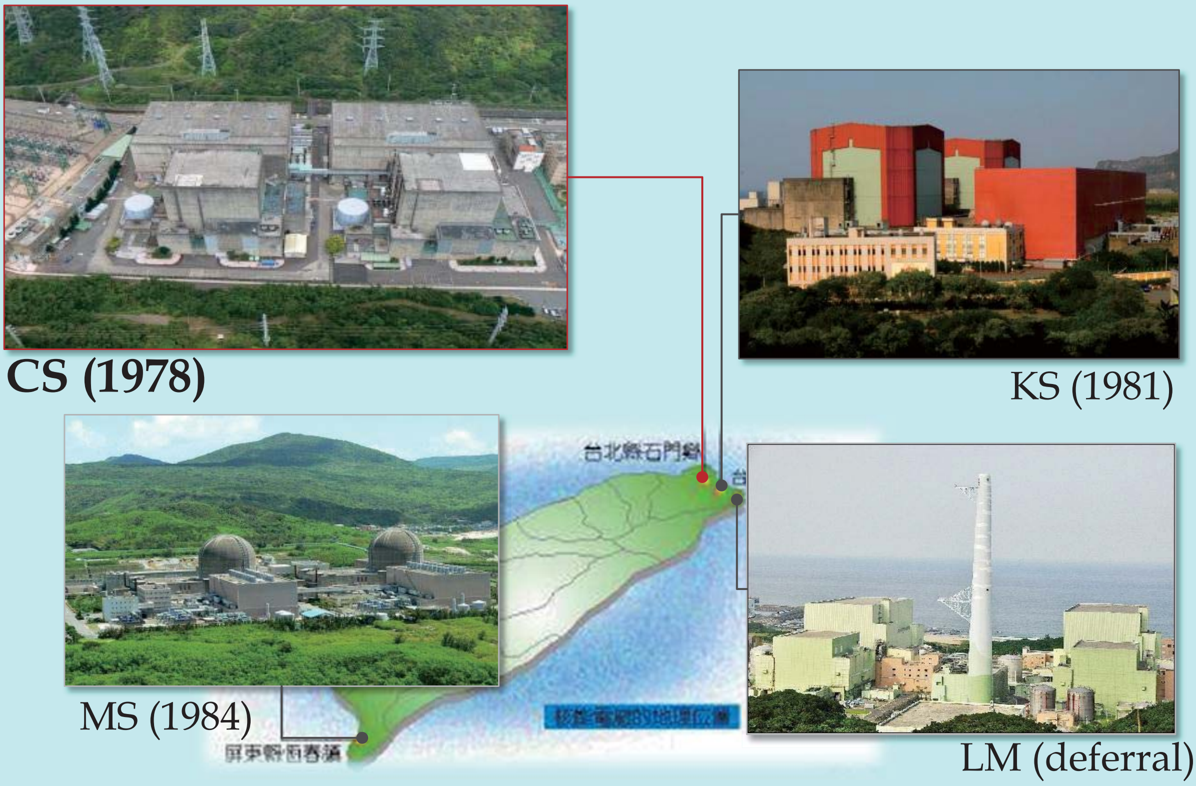
附件一

台電公司核能一廠除役計畫簡報

Application for Decommissioning Permit and Decommissioning Planning for Chinshan Nuclear Power Plant

16th WPDD Meeting, NEA
Issy-les-Moulinaux, France
23-25 November, 2015

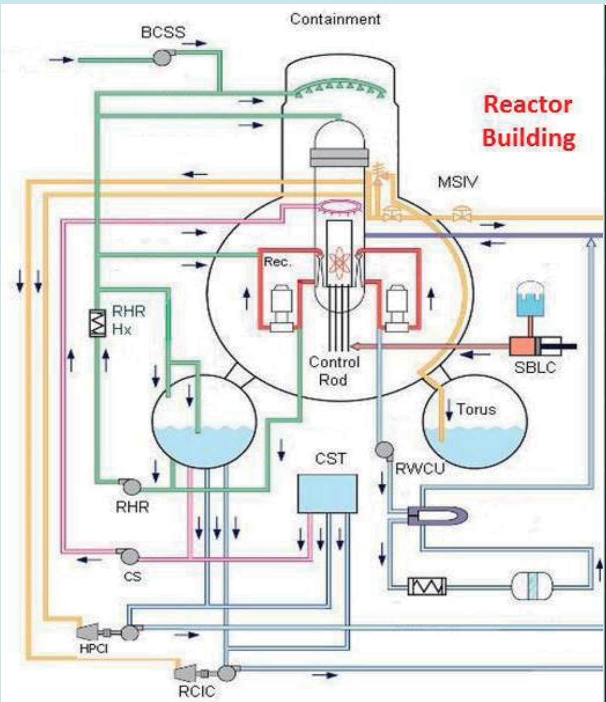
Overview of Nuclear Power Plants in Taiwan



Overview of Nuclear Power Plants in Taiwan

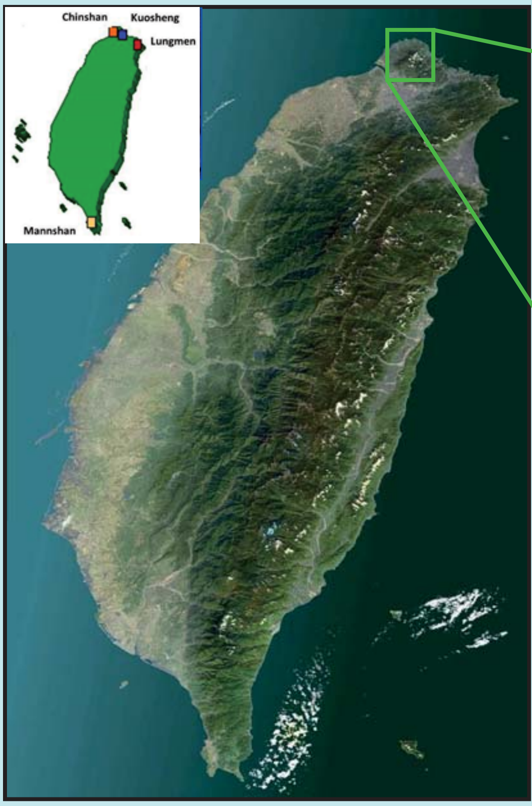
Plant	Chinshan	Kuosheng	Maanshan	Lungmen
Reactor Type	BWR-4	BWR-6	PWR	ABWR
Turbine Manufacturer	Westinghouse	Westinghouse	General Electric	Mitsubishi
Containment Type	Mark-I	Mark-III	Large, Dry Post-Tensioned	Reinforced Concrete Containment Vessel
Thermal	1,804 MWt	2,943 MWt	2,822 MWt	3,926 MWt
Electric	636 MWe	985 MWe	951 MWe	1,350 MWe
Commercial				--
Unit 1	12/6/1978	12/28/1981	7/27/1984	--
Unit 2	7/16/1979	3/15/1983	5/18/1985	--

Overview of Chinshan Nuclear Power Plant



Reactor Type	BWR-4 (GE)	
Turbine Manufacturer	Westinghouse	
Containment Type	Mark-I	
Thermal	1804 MWt	
Electric	636 MWe	
	Unit 1	Unit 2
Commercial Operation	since 1978.12.06	since 1979.07.16
License Expiration Date	2018.12.05	2019.07.15

Overview of Chinshan Nuclear Power Plant



Geographical Location

- Chenghwa, Shimen District, New Taipei City
- The northeast coast of the island
- The first decommissioning NPP in Taiwan

National Energy Policy after Fukushima Event

Declared by President on November 3, 2011：

- **Ensure safety of nuclear energy**
- **Develop environment -friendly low-carbon green energy production**
- **Steadily reducing the dependence on nuclear power and move gradually towards nuclear-free homeland**
- **Each of existing operating nuclear power plants will be decommissioned when its 40-year operation license expires**

Regulations

- **Nuclear Reactor Facilities Regulation Act** (2003.01.15 revised)

Article 21

The decommissioning of nuclear reactor facilities shall adopt **the method of dismantlement** and shall be completed within the period prescribed by the competent authorities.

Article 23

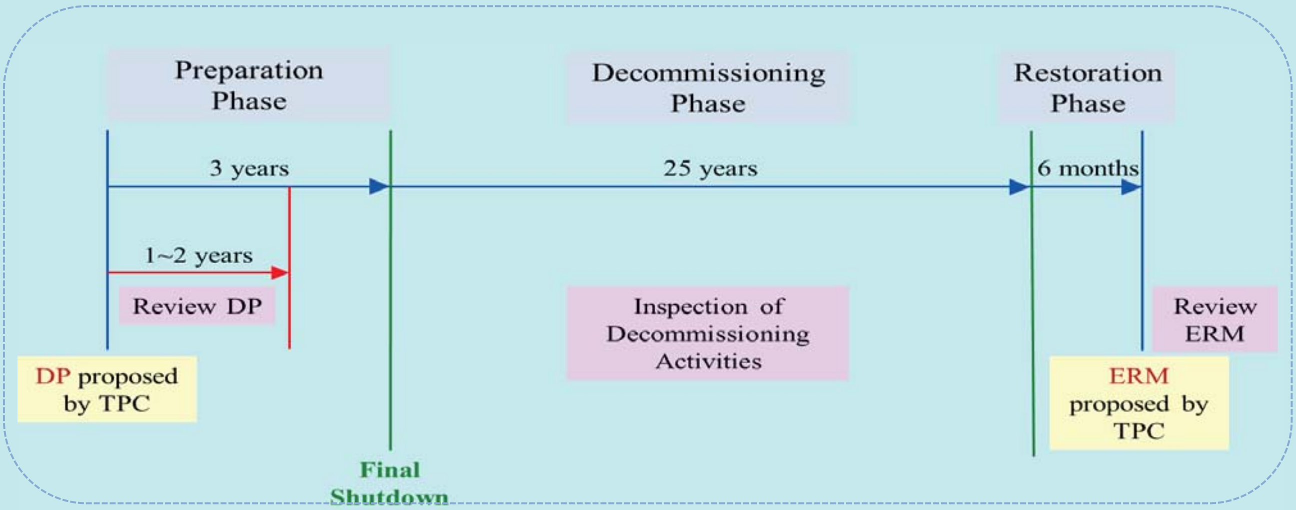
The decommissioning plan referred to in the preceding Paragraph **shall be submitted by the licensee three years prior** to the scheduled permanent cessation of operation of nuclear reactor facilities.

- **Enforcement Rules for the Implementation of Nuclear Reactor Facilities Regulation Act** (2003.08.27 promulgated)

Article 16

The decommissioning of nuclear reactor facility shall be completed **within twenty- five (25) years** upon obtaining the permit for decommissioning granted by the competent authorities.

Regulation Timeline of Decommissioning
for Nuclear Reactor Facilities in Taiwan

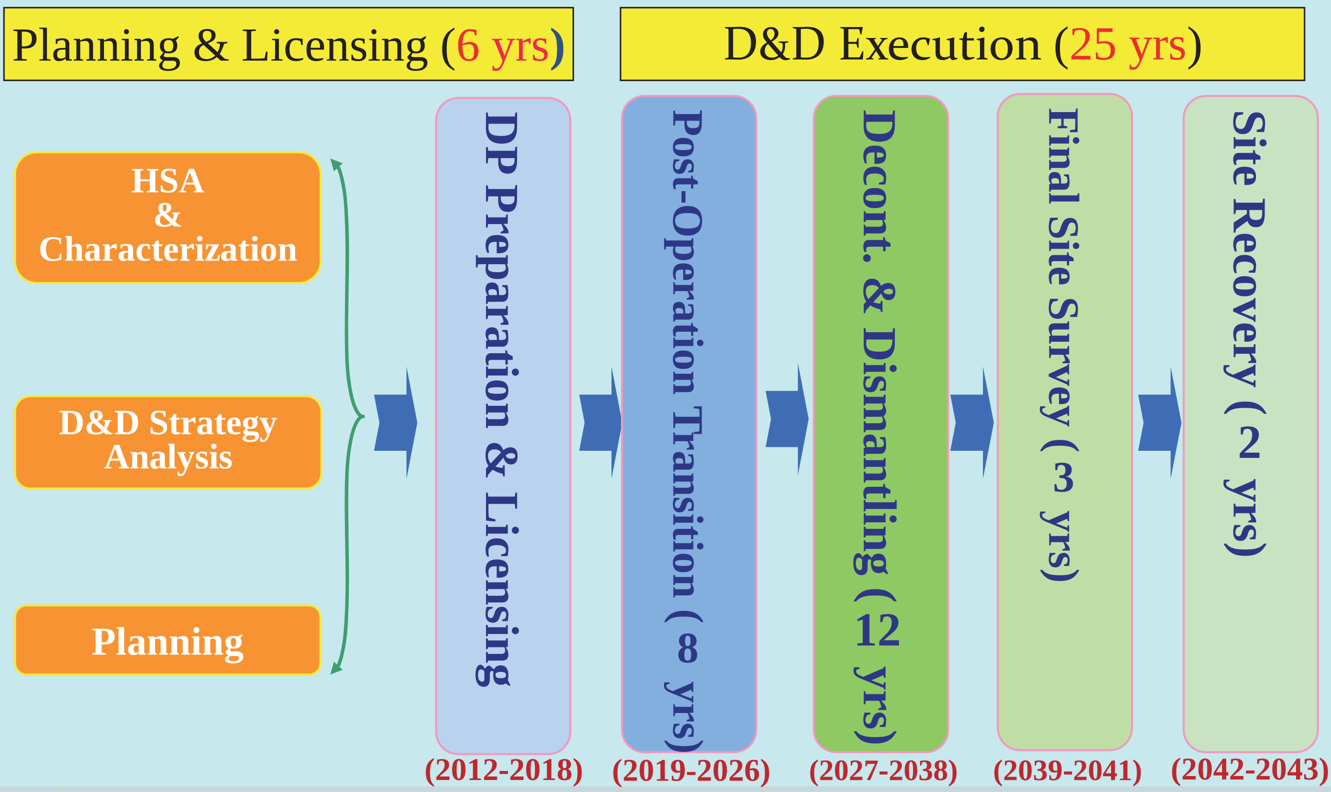


Nuclear Reactor Facilities Regulation Act

Article 28

Within six months of completion of the decommissioning plan of nuclear reactor facilities, the licensee shall submit to the competent authorities for review and examination the report on environmental radiation monitoring on the site.

Schedule of Chinshan NPP Decommissioning



Chinshan NPP Decommissioning Activities

Cessation

Transition Phase (8 years) — 0 – 8 years
- Final shutdown
- SNF transferred to SFP
- Site characterization survey
- Engineering planning
- Systems drainage and decontamination
- Set up ISFSI & radwaste storage area

Dismantlement Phase (4+8 years)

9 – 12 years
- SNF transferred to ISFSI
- TB large components dismantlement

13 – 20 years
- RPV and internal dismantlement
- Reactor coolant system piping dismantlement
- SFP dismantlement
- Primary containment dismantlement
- Decontamination of concrete and buildings

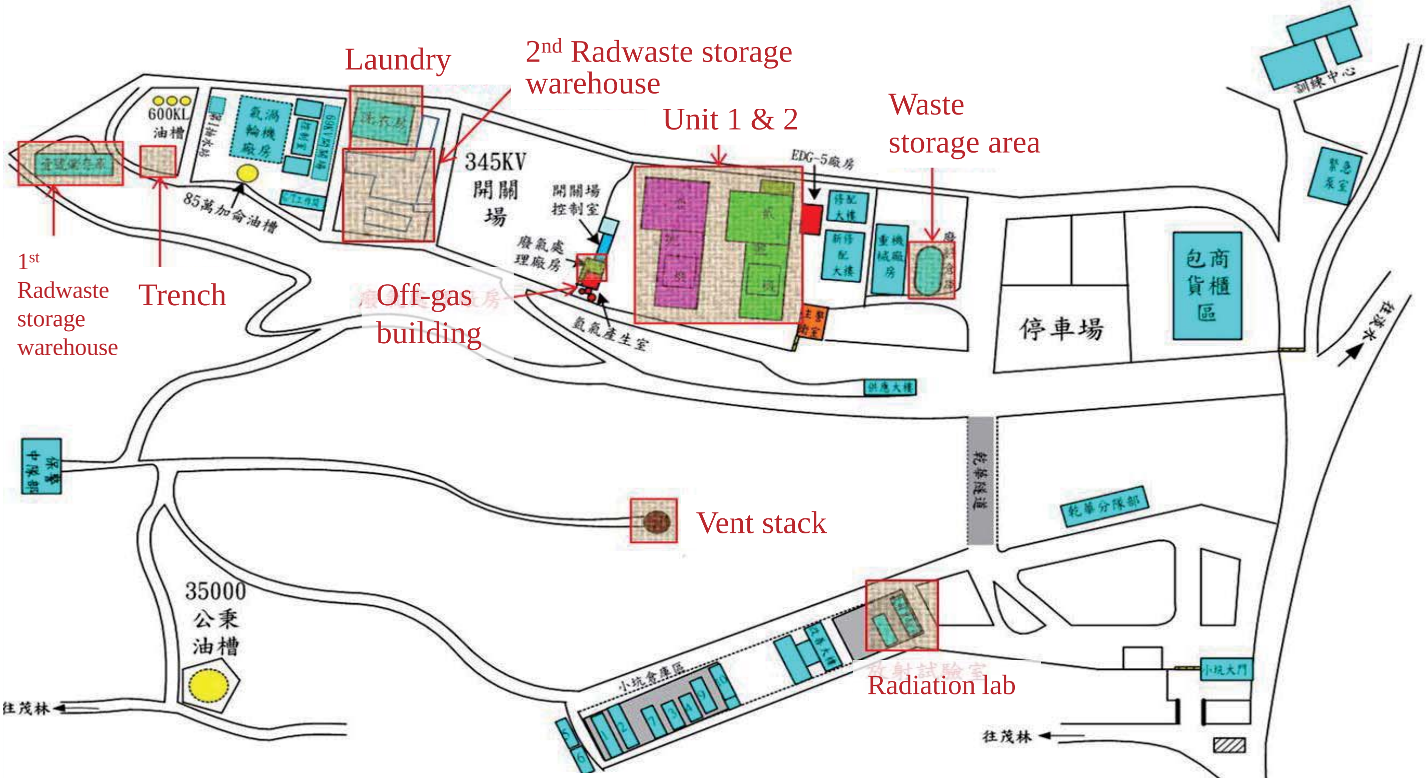
Final Site Survey Phase (3 years) — 21 – 23
- CSB and TB buildings demolition
- Land remediation (if necessary)
- Final site survey

Site Restoration Phase (2 years) — 24 – 25
- FSS reports
- Site restoration

Site Utilization Plan of Chinshan NPP

Characteristic Survey

Historic Site Assessment



Contaminated buildings/surfaces/systems/equipment

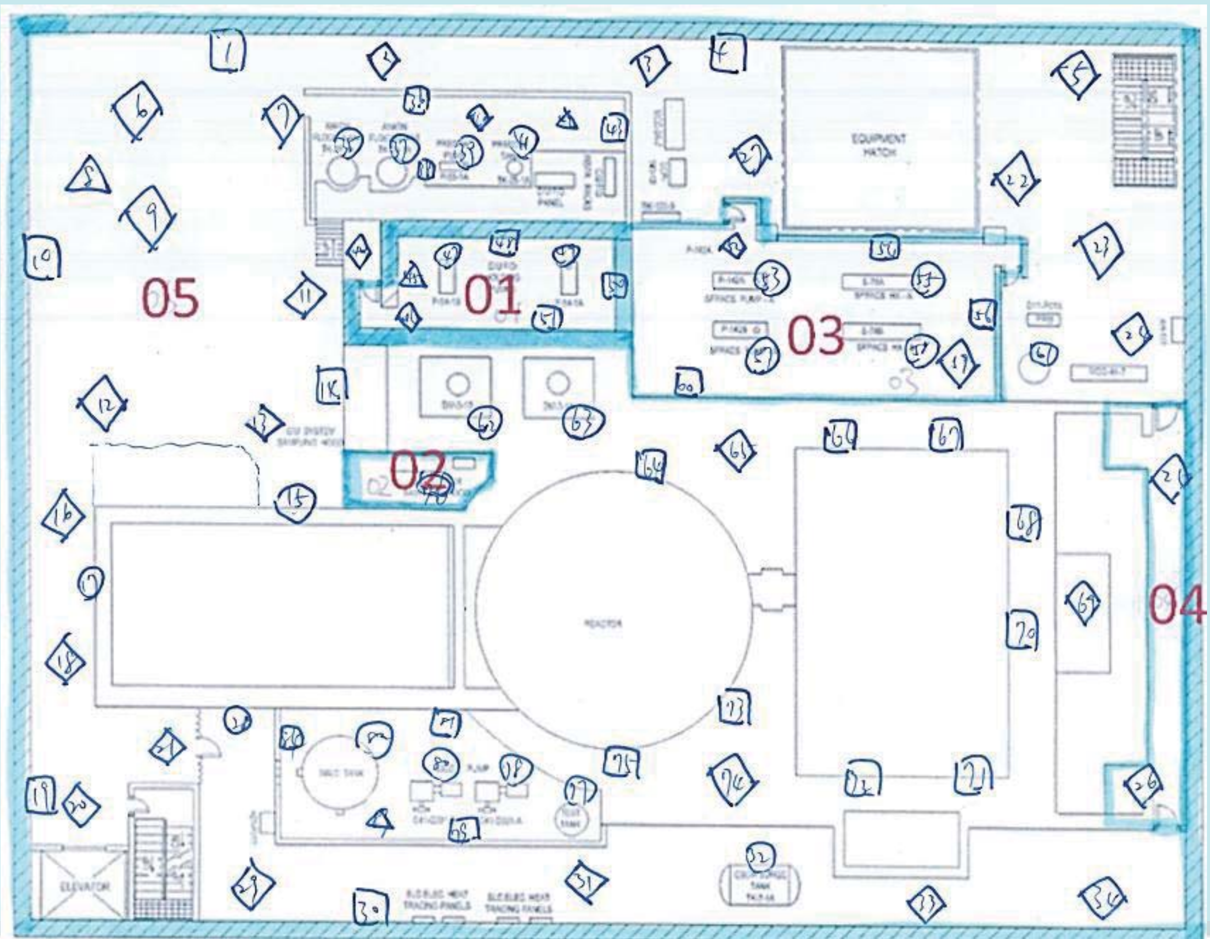
Survey Package Implementation

Classification		
A	Affected Plant Surfaces and Structures Radiological Survey Packages	1, 2, 3, 4, 5, 6
B	Unaffected Plant Surfaces and Structures Radiological Survey Packages	1, 2, 3, 4, 5
C	Affected Plant Systems Radiological Survey Packages	1, 2, 3, 4, 5
D	Unaffected Plant Systems Radiological Survey Packages	
R	Affected/Unaffected Environment Radiological Survey Packages	1, 4, 5

1. scans
2. gross activity measurements
3. removable activity measurements
4. exposure rate measurements
5. collection and radiological analysis of samples (if applicable)
6. contamination profile sampling (if applicable)

Characteristic Survey

Classification	Survey packages	Measurement points
Affected structures and surfaces (A)	47	3,767
Unaffected structures and surfaces (B)	14	2,897
Affected systems (C)	47	45
Unaffected systems (D)	31	
Environment (affected/unaffected) (R)	12	4,011

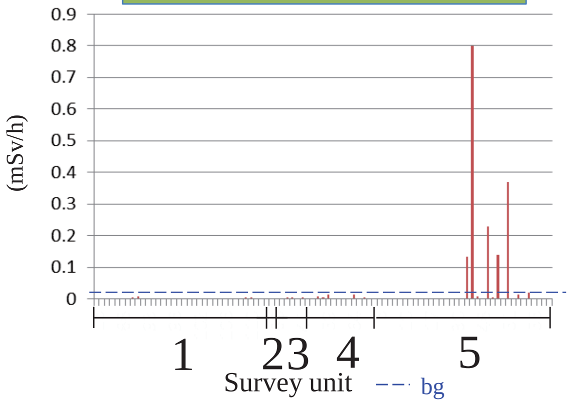


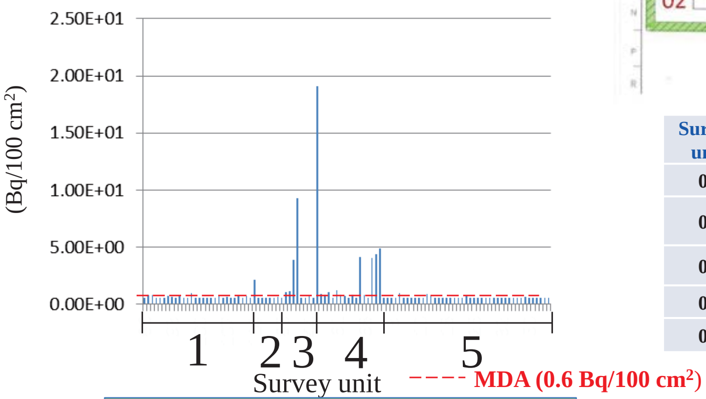
Reactor building 4F

△: ceiling
○: equipment
□: wall
◇: floor

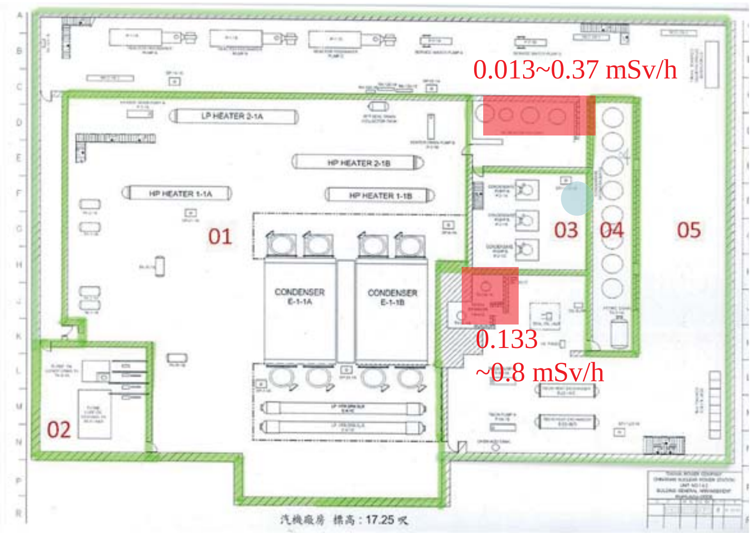
Unit 2 Turbine building 17.25' (A20100)

Dose rate: total 89 points





Wipe test: total 109 points



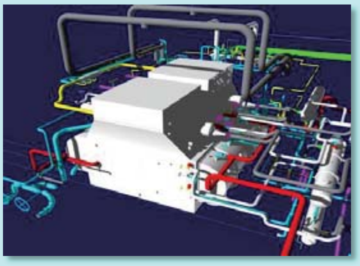
Survey unit	Name	Dose rate (mSv/h)	Contamination (Bq/100 cm^2)
01	Main condenser	0.00021~0.0075	MDA~2.18
02	Turbine lubricant storage tank	0.00019~0.00029	MDA~0.69
03	Condensate pump	0.00055~0.0042	MDA~19.10
04	Demineralizer	0.00055~0.013	MDA~4.86
05	Other areas	0.00001~0.8	MDA~1.01

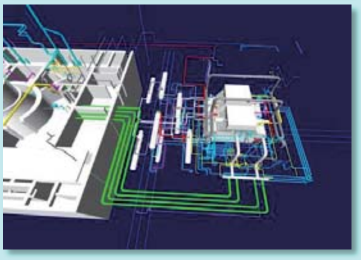
Date：103.05.12
BG：0.0001 mSv/h

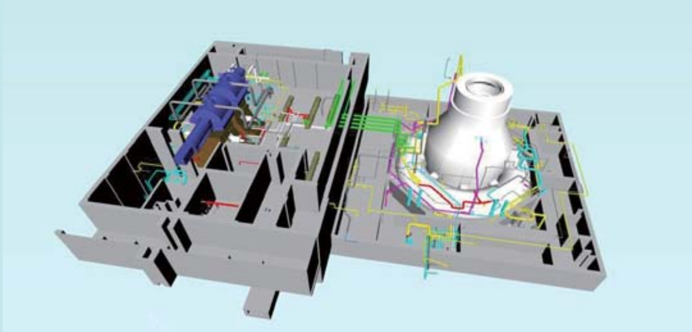
3-D Model Construction

3D Model for SSCs

Isometric diagrams	⇨		⇨	D&D plan
Characterization	⇨	3D model	⇨	Waste inventory
System Classification	⇨		⇨	Radiation protection & Training





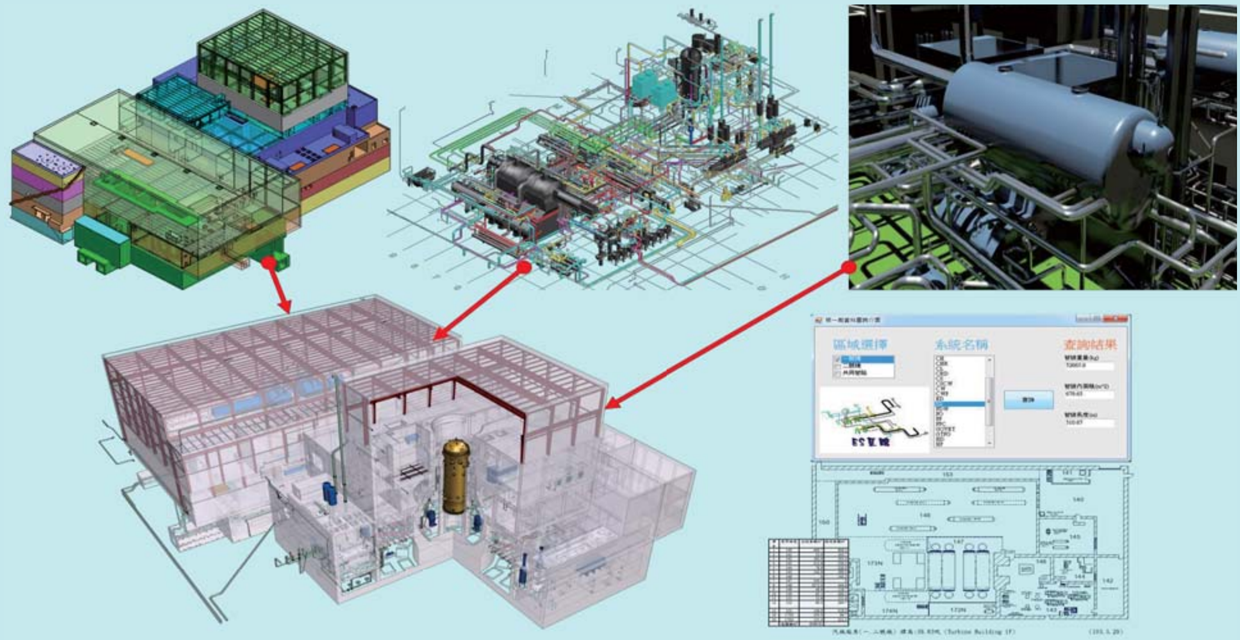


Current Results of 3-D Modeling

- 3-D Model of Chinshan Nuclear Power Plant

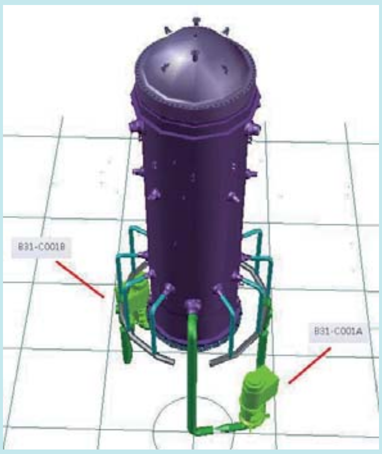
Current Results of 3-D Modeling

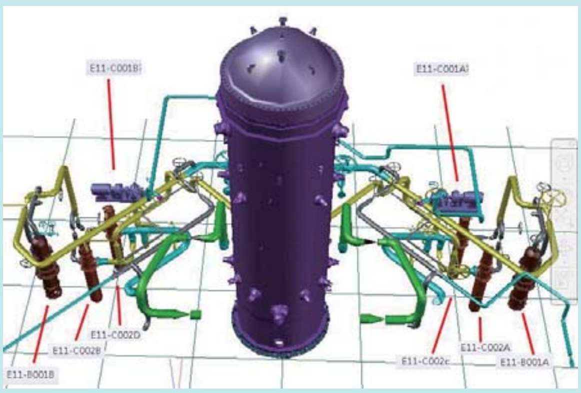
- 3-D models of structures, systems, components and pipes for Chinshan NPP



Current Results of 3-D Modeling

- Equipment and pipes of Recirc and RHR system





RHR System

Recirc System

Main equipment of the Recirc

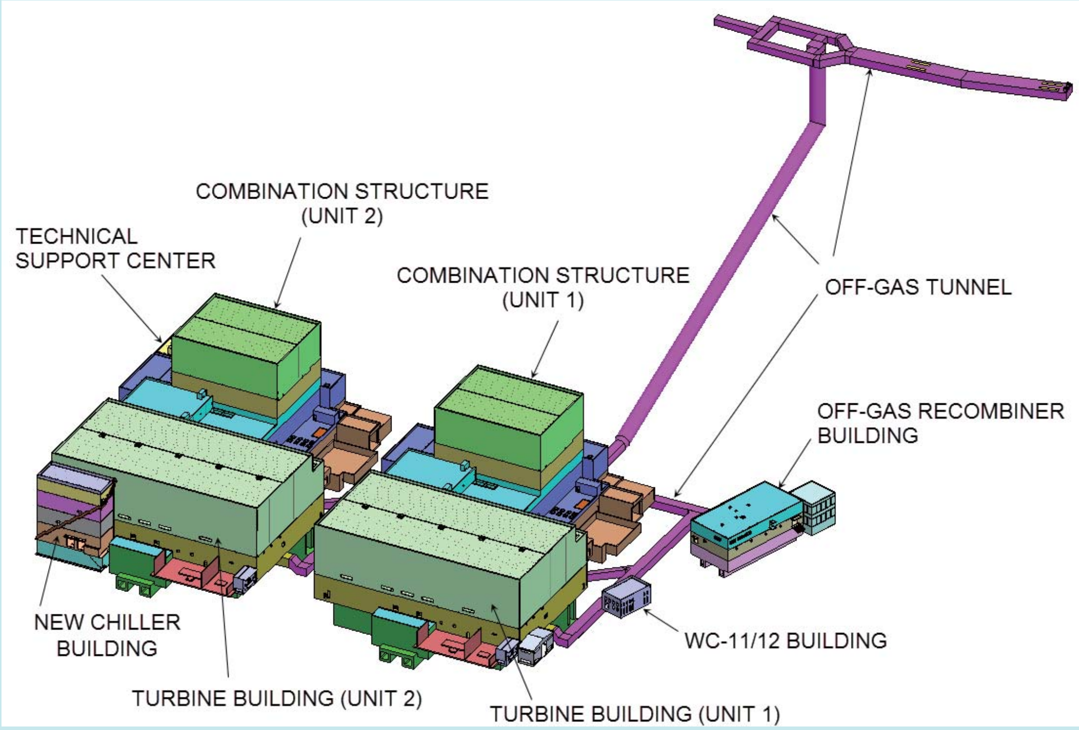
Name of equipment	Number of equipment
REACTOR RECIRCULATION PUMP	B31-C001A
REACTOR RECIRCULATION PUMP	B31-C001B

Main equipment of RHR

Name of equipment	Number of equipment
RHR HEAT EXCHANGER	E11-B001A
RHR HEAT EXCHANGER	E11-B001B
RHR SERVICE WATER BOOSTER PUMP	E11-C001A
RHR SERVICE WATER BOOSTER PUMP	E11-C001B
RHR PUMP	E11-C002A
RHR PUMP	E11-C002B
RHR PUMP	E11-C002C
RHR PUMP	E11-C002D

Current Results of 3-D Modeling

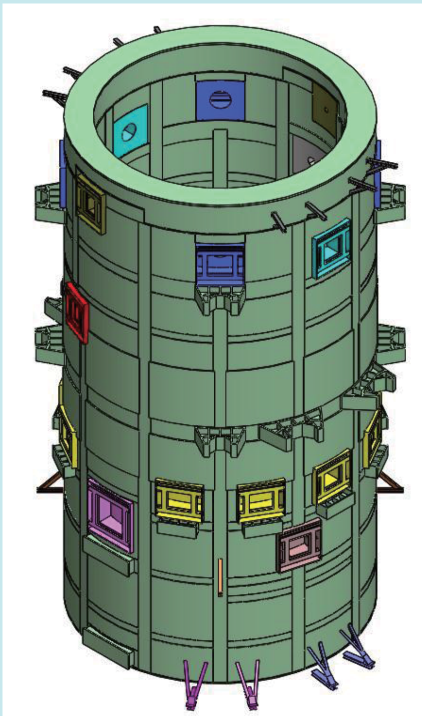
- The main buildings of Chinshan NPP



Current Results of 3-D Modeling

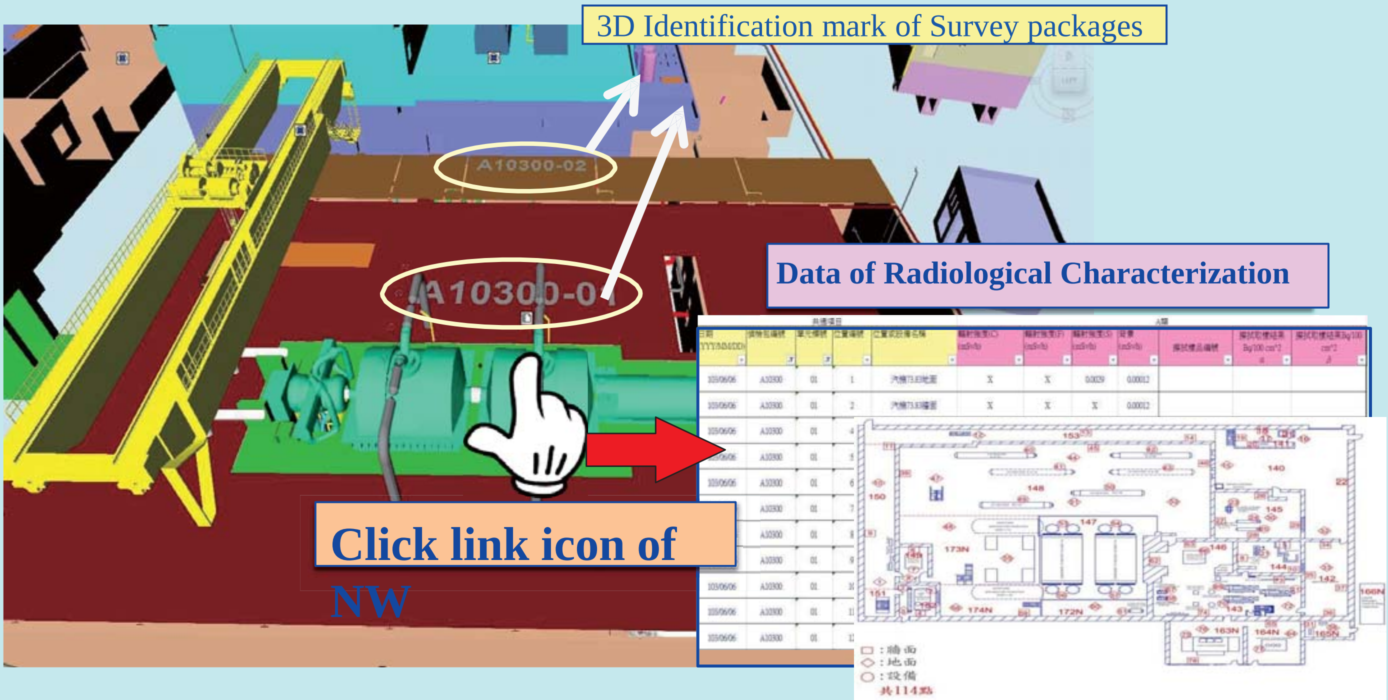
- Statistics of biological shield

	Volume (m^3)	Weight (MT)
Steel	22.4	176.7
Concrete	203.2	487.7



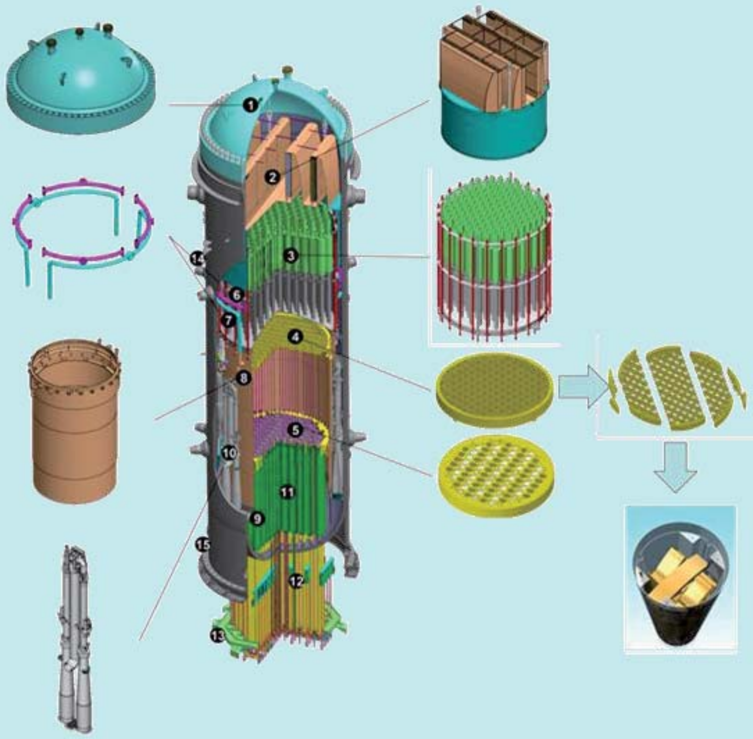
Current Results of 3-D Modeling

- 3D model combined with radiological characterization data



Current Results of 3-D Modeling

- Reactor pressure vessel and its internals

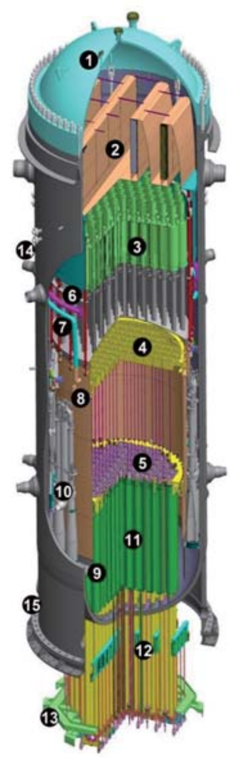


No.	component name
1	Vessel Head
2	Steam Dryer
3	Steam Separator and Shroud Head
4	Top Guide
5	Core Plate
6	Feedwater Sparger
7	Core Spray Sparger
8	Core Shroud
9	Baffle Plate
10	Jet Pump Assemble
11	Control Rod Guide Tube
12	CRD Driver Housing
13	CRD Driver Support Structure
14	RPV body
15	Vessel Support Skirt

Current Results of 3-D Modeling

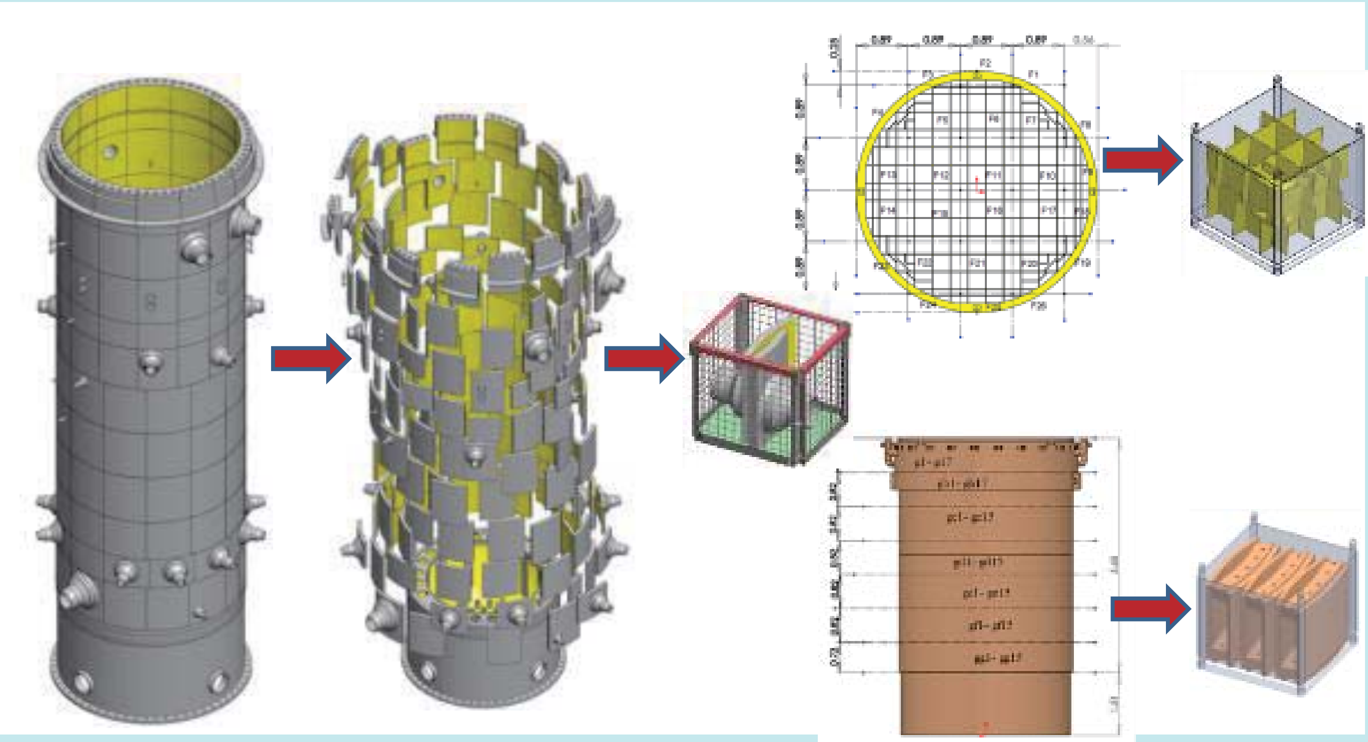
- Cutting plan of the RPV and its internals

Name	Cutting method	Cutting location
1. Vessel Head	Mechanical cutting or thermal cutting (in air)	5F floor of reactor building (Temporary tent)
2. Steam Dryer	Mechanical cutting or thermal cutting (underwater)	Storage pool
3. Steam Separator and Shroud Head	Mechanical cutting or thermal cutting (underwater)	Storage pool
4. Top Guide	Mechanical cutting or thermal cutting (underwater)	Cavity, Storage pool
5. Core Plate	Mechanical cutting or thermal cutting (underwater)	Cavity, Storage pool
6,7. Feedwater Sparger and Core Spray Sparger	Mechanical cutting or thermal cutting (underwater)	Cavity, Storage pool
8. Core Shroud	Mechanical cutting or thermal cutting or abrasive waterjet (underwater)	Cavity, Storage pool
10. Jet Pump Assemble	Mechanical cutting or thermal cutting (underwater)	Cavity, Storage pool
14. RPV body	Mechanical cutting or thermal cutting or abrasive waterjet (in air & underwater)	Cavity, 5F floor of reactor building



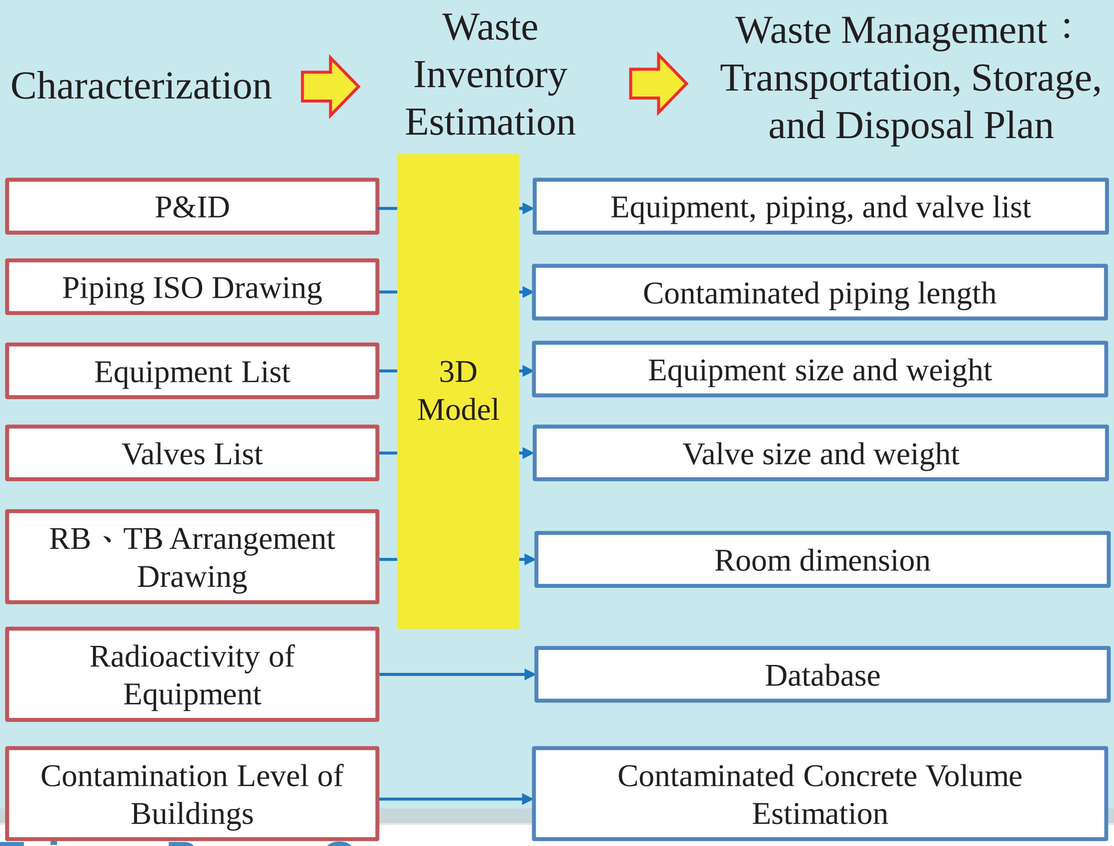
Current Results of 3-D Modeling

- Cutting plan of the RPV and its internals



Radioactive Waste Inventory

Flowchart of Waste Inventory Estimation



RW Classification Results

Data updated to Nov. 2015 (*Unit 2)

Specific Activity (TBq/m³)	Core Shroud	Top Guide Plate	Lower Guide Plate	Jet Pump	RPV Head	RPV	Steam Separator and Shroud Head	Dryer Assembly	Control Rod Guide Tube Assembly	Control Rod Driven System
C-14	4.00E-01	5.09E+00	1.55E-01	1.03E-01	2.10E-10	8.22E-05	1.39E-03	1.59E-07	1.34E-03	3.50E-08
Ni-59	2.62E+00	2.62E+01	1.00E+00	6.78E-01	5.11E-10	1.90E-04	9.45E-03	1.09E-06	8.81E-03	2.35E-07
Ni-63	2.75E+02	3.22E+03	1.04E+02	7.03E+01	5.34E-08	2.00E-02	9.78E-01	1.13E-04	9.11E-01	2.44E-05
Nb-94	3.64E-03	6.22E-02	2.43E-03	1.13E-03	6.07E-12	1.01E-06	9.50E-06	1.15E-09	1.48E-05	6.73E-09
Classification	GTCC	GTCC	C	C	A	A	A	A	A	A

Radioactive Waste Inventory

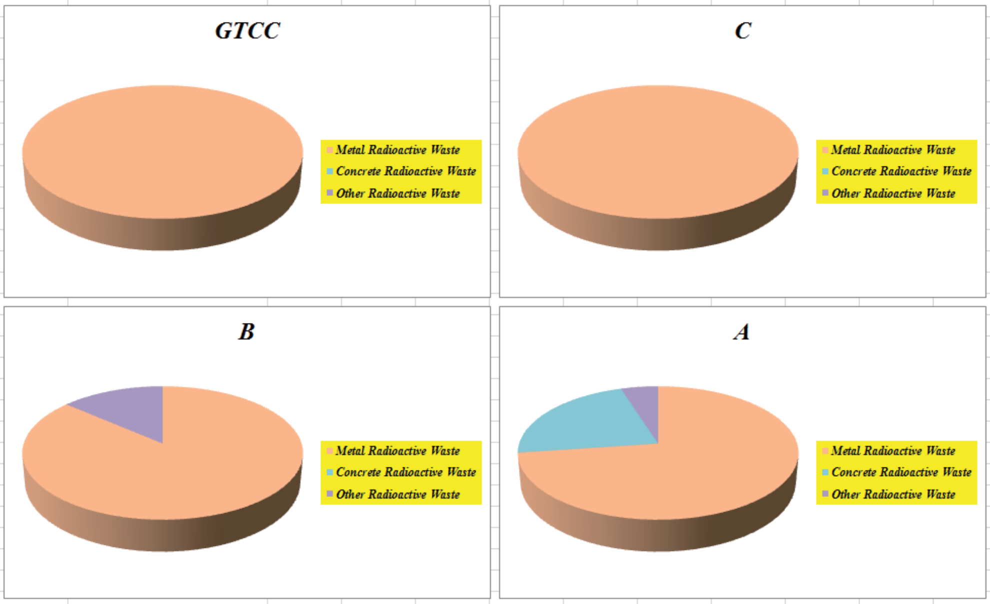
Data updated to Nov. 2015 (*Chinshan NPP)

Category	Weight (MT)	%	Activity (Bq)	%	55 Gallon Drums
Metal RW[1]	28,379		2.58E+16		44,349
Activated	1,223	4.3 %	2.47E+16	95.6 %	5,340
Contaminated	8,933	31.5 %	1.13E+15	4.4 %	39,009
Clearence	18,223	64.2 %	1.56E+06	~ 0 %	79,576
Concrete RW[2]	2,685		6.98E+13		13,422
Activated	1,140	42.5 %	1.14E+09	~ 0 %	5,700
Contaminated	1,545	57.5 %	6.98E+13	~ 100 %	7,722
Other RW	724		1.00E+14		4,020
Dry Active Waste (Volume Reduced)[3]	242	33.4 %	~ 0	~ 0 %	2,420
Wet Solid Waste (Solidified)[4]	452	62.4 %	1.00E+14	~ 100 %	1,003
Insulation[5]	30	4.1 %	1.63E+10	~ 0 %	597
Total	31,788		2.60E+16		61,791

Note：Package Factor
[1] Metal RW：229 kg per 55 gallon drum
[2] Concrete RW：200 kg per 55 gallon drum
[3] Dry Active Waste：100 kg per 55 gallon drum
[4] Wet Solid Waste：450 kg per 55 gallon drum
[5] Insulation：49 kg per 55 gallon drum

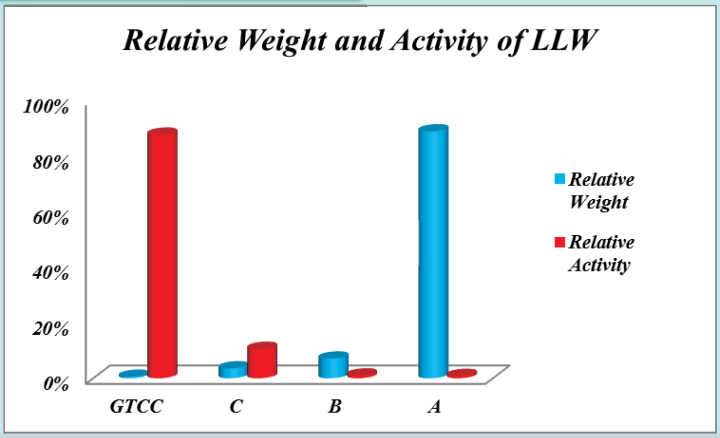
Radioactive Waste Inventory

Category	GTCC		C		B		A	
	MT	%	MT	%	MT	%	MT	%
Metal Radioactive Waste	72	100 %	481	100 %	828	86 %	8,775	73 %
Concrete Radioactive Waste	0	0 %	0	0 %	0	0 %	2,685	22 %
Other Radioactive Waste	0	0 %	0	0 %	131	14 %	593	5 %
Total	72	100 %	481	100 %	959	100 %	12,053	100 %



Radioactive Waste Inventory

Category	Weight (MT)	%	Activity (Bq)	%
GTCC	72	1 %	2.28E+16	88 %
C	481	4 %	2.74E+15	11 %
B	959	7 %	2.56E+14	1 %
A	12,053	89 %	2.14E+14	1 %
Total	13,565	100 %	2.60E+16	100 %



Data updated to Nov. 2015 (*Unit 2)

Decommissioning Permit Application --- Milestone

- Draft version of integrated decommissioning plan completed in October, 2015, followed by internal final review.
- Chinshan NPP Decommissioning Plan will be submitted to Regulator for review and approval by the end of November, 2015.
- Expectation on the review process of decommissioning plan be successfully accomplished by regulators before permanent cessation of Chinshan NPP.

Thanks for Your Attention

附件二

各國除役相關資訊更新資料

16th Meeting of the Working Party on Decommissioning and Dismantling (WPDD) on 23-25 November 2015

Canada Update Report for WPDD-16

November 19, 2015

(Agenda Item #12.b)

Strategic Areas	Issues
Policy, regulation and strategy	<u>AECL Restructuring</u> The restructuring of AECL's Nuclear Laboratories was launched on February 28, 2013 when the Minister of Natural Resources announced that the Government of Canada would engage in a procurement process to implement a Government-owned, Contractor-operated (GoCo) model for the management and operation of the Laboratories. On November 3, 2014, AECL's employees and operations were reorganized into a wholly-owned subsidiary called Canadian Nuclear Laboratories Ltd (CNL). The new business entity was created to enable the eventual takeover of the operations of the Nuclear Laboratories by a private-sector contractor. The large majority of AECL's 3400 employees became employees of CNL. On June 26, 2015, the Minister of Natural Resources announced that the Government had selected Canadian National Energy Alliance Ltd (CNEA) as the preferred bidder to manage and operate CNL pursuant to contracts that implement the GoCo model. The transaction was completed on September 13, 2015 with the transfer of the shares of CNL from AECL to CNEA, the new operator of AECL's Nuclear Laboratories. Under this model, AECL will deliver on its mandate through contractual agreements with CNL for science and technology (S&T) and decommissioning and waste management (DWM) services. The nuclear decommissioning and waste management work at AECL sites that was previously carried out under the Nuclear Legacy Liabilities Program (NLLP) was successfully transitioned into CNL's DWM Mission, and the NLLP formally ended as a NRCan Program on September 13, 2015. To prepare for its new role, AECL was re-organized and re-focused as an expert-based Crown corporation. The "new" AECL is now a small organization with approximately 50 highly-qualified and specialized staff who will oversee the work of CNL and the Contractor.

	CNL's plan for accelerating decommissioning and waste management work at AECL sites Key objectives for CNL and AECL over the next 10 years include: **Chalk River Laboratories Capital Build Program** • Complete construction of new laboratory complex • Nuclear Fuels Research Centre • Nuclear Materials Storage Facility • Upgrade Site Infrastructure (Power, Security, etc) **Operations** • Return the U-2 Loop to service in fiscal year 2015/16 • Operate the NRU research reactor until 2018 March • Maintain Moly-99 Production Facility in standby mode until 2018 March **Decommissioning and Waste Management** • Construct low-level waste disposal facility at Chalk River Laboratories (CRL), make ready for operation by 2019 October • Decommission 120 buildings at CRL by 2025 • Decommission the Nuclear Power Demonstration prototype reactor by 2021 June • Decommission Whiteshell Laboratories by 2023 October Ontario Power Generation's (OPG) planned decommissioning of the Pickering Nuclear Generating Station (NGS) OPG submitted a comprehensive plan on decommissioning strategies for the Pickering NGS to the Canadian Nuclear Safety Commission (CNSC) in 2013. The comprehensive decommissioning strategy (CDS) for the Pickering NGS facility identified the preferred strategy as deferred decommissioning. This strategy involves storing and monitoring the reactors and station for 30 years after shut-down to allow radiation and thermal levels to decay prior to dismantling, demolition and site restoration. The CDS for the Pickering NGS describes the four stages of post-shutdown as: 1) Stabilization (or preparation for safe storage), 2) Storage and Surveillance (or safe storage), 3) Dismantling and Demolition, and 4) Site Restoration. OPG's overview of the overall decommissioning strategy for the Pickering NGS states that the fuel and heavy water will be removed from all reactors once the units have reached the end of commercial operations in 2020, and that the units will be placed in permanent safe storage. The placement in safe storage or stabilization activities is expected to be complete by 2023. The surveillance and storage phase is expected to last approximately 30 years.

Dismantling and demolition (D&D) of the plant will begin around 2051 with site restoration in 2064.

OPG plans to manage the end-of-life of the Pickering NGS through the following decommissioning plans:

- A Stabilization Activity Plan (SAP),
- A Storage and Surveillance Plan (SSP), and
- A Detailed Decommissioning Plan (DDP).

<u>Regulatory matters</u>

The CNSC is embarking on modernizing the waste and decommissioning regulatory framework. This project is in response to the 2009 International Regulatory Review Services (IRRS) recommendation: "*CNSC should improve its regulatory framework including regulatory documents and guides with respect to radioactive waste management to ensure that radioactive waste is managed in a consistent manner*"

CNSC's current framework, developed in 2000, has not kept pace with lessons learned and international best practices. While allowing the CNSC to maintain safe and effective oversight, it has relied heavily on:

- "any other information" clause in regulations to obtain information needed to assess applications
- adjusting ("downgrading") requirements for certain low-risk Class I Facility licensees
- extensive use of license conditions, in the absence of specific regulatory provisions
- adjusting ("upgrading") requirements for certain operations regulated under waste nuclear substance licences

CNSC's planned regulatory framework improvement includes developing new regulatory documents and updating existing ones, and developing Waste and Decommissioning Regulations.

The new and revised regulatory documents will address the requirements and guidance for:

- Waste facilities and repositories including general requirements and concepts and modules for different facility types and licensing stages.
- Waste management programs - a new regulatory document, incorporating and updating P-290; principles of waste management, e.g. minimization; and CNSC expectations for waste management programs across all facility types.
- Decommissioning - a new regulatory document, incorporating and updating G-219 which will include the definition of decommissioning, a description of phases of decommissioning, and international best practices. A discussion paper on decommissioning strategies for input to the revision of G-219 is being finalized by CNSC.

<table>
<tr><td></td><td>The Regulatory Framework Analysis for each document will confirm the document's scope, taking Canadian Standards Association standards into account, to avoid duplication; confirm placement of documents in the framework, and potential for consolidation, incorporation, and linkages with other regulatory documents, e.g., RD/GD-370: Management of Uranium Mine Waste Rock and Mill Tailings and CNSC guidance G-206 on financial guarantees.

The development of Waste and Decommissioning Regulations is intended to:

• Define new waste facility/repository categories based on activities and risk, rather than inventory
• Set licence application requirements for waste facilities and repositories
• Move standardized licence conditions and regulatory oversight requirements into regulation
• Consolidate and Update Waste Program Requirements
• Consolidate and Update Decommissioning Requirements
• Provide clarity by defining key terms

CNSC is developing a discussion paper on modernizing the CNSC waste regulatory framework which is expected to be ready for public consultation in 2016.</td></tr>
<tr><td>Funding and costs</td><td>Canada's 2014-15 Consolidated Financial Statements include a $6.49 billion liability (Net Present Value, or NPV) to address nuclear facility decommissioning and waste management responsibilities at AECL sites.

The following financial guarantees are in place (as of November 2015) for decommissioning Nuclear Generation Stations (NGS), and the long-term management of nuclear fuel waste:

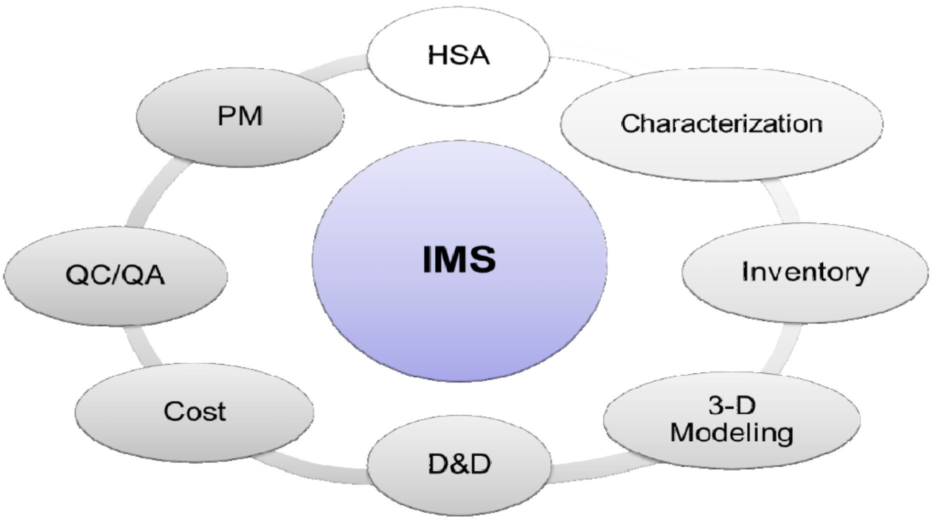
• Ontario Power Generation (Pickering, Darlington and Bruce NGSs) $17.004 billion (includes long-term management costs for low- and intermediate-level waste from NGS operations)
• New Brunswick Power (Point Lepreau NGS) $720.3 million
• Hydro-Québec (Gentilly-2 NGS) $685 million</td></tr>
<tr><td>Techniques and Innovation</td><td>The GoCo model is now in place for the management and operation of AECL sites, including Chalk River Laboratories (CRL), Whiteshell Laboratories (WL), and the Nuclear Power Demonstration (NPD), Douglas Point and Gentilly-1 prototype reactor sites. Changes in approach that will be implemented by the GoCo contractor include the construction of a Low-Level Waste (LLW) repository at CRL, followed by an accelerated decommissioning program at CRL to accommodate new research facilities. Further, the GoCo contractor intends to pursue in-situ decommissioning for the WL research reactor and the NPD prototype reactor. The GoCo contractor is currently developing an integrated baseline which will align the decommissioning programs across the estate, including the transfer of nuclear fuel and radioactive waste from WL to CRL.</td></tr>
</table>

Materials management and site release	The GoCo contractor sees waste management as the key to effectively delivering the DWM Mission at AECL sites. The contractor's strategy is to plan for disposal from the start, minimize handling, and characterize the waste for packaging to avoid the need for future repackaging. Recycling and re-use is driven by economics.
Human and organisational factors	As noted above, Canada has implemented a GoCo model for the management and operation of its Nuclear Laboratories, which includes the delivery of programs and projects to address Canada's decommissioning and waste management responsibilities at AECL sites and historic waste sites across Canada.
Stakeholder participation and knowledge management	The current strategy for the WL and NPD reactors is to fully dismantle and remove the reactors. Modification of this strategy to in-situ decommissioning will require engagement with regulators and stakeholders. There is an established approval process which outlines durations for public consultation and regulatory input. However the clock can be reset at various points during the process depending on the response from stakeholders. A LLW disposal facility at CRL had been previously planned. The GoCo contractor plans to accelerate the schedule, with the objective of having the facility in operation by the end of 2019. The GoCo contractor recognizes the importance of communications and engagement with stakeholders, and is planning an extensive and open process.
Topical Session (2015): Extended and Deferred Decommissioning	

Country Update on Decommissioning – WPDD 16

Country: Chinese Taipei

Strategic Areas	Issues
Policy, regulation and strategy	The national policy on decommissioning is defined in the Management of Decommissioning of Nuclear Reactor Facilities promulgated by Executive Yuan(Cabinet) in 1991, the immediate dismantling approach(DECON) was adopted as the strategy for the decommissioning of nuclear reactor facilities. The Nuclear Reactor Facilities Regulation Act (NRFRA), promulgated in Jan. 2003, stipulated the regulations for the decommissioning of Nuclear Reactor Facilities. Atomic Energy Council (AEC) also promulgated the Enforcement Rules for the Implementation of NRFRA in Aug. 2003. The Enforcement Rules established the standards for the radiation dose limit of a post-decommissioning nuclear reactor facility site and guidelines for the final status survey report. July 2004, AEC promulgated the Regulation for the Review and Approval of Applications for Decommissioning Permit of Nuclear Reactor Facilities, which stipulated the procedures of applying for a decommissioning permit. In accordance with the Environmental Impact Assessment Act, Taiwan Power Company (TPC) shall conduct the environmental impact assessment (EIA) for decommissioning nuclear power stations. In accordance with the NRFRA, TPC shall submit the Decommissioning Plan (DP) at least three years prior to the scheduled permanent cessation of operation of a nuclear power station. The decommissioning of a nuclear power station shall be completed within 25 years upon obtaining the decommissioning permit.
Funding and costs	Decommissioning will be financed by the Nuclear Backend Fund established in 1986 and operated by the government. The budget for the decommissioning of Chinshan NPP is NTD 18.2 billion (~US$ 606 million, including 15% for contingency).
Techniques and Innovation	NPP reactor pressure vessels are planned to be dismantled into pieces. All decommissioning plans will be based on currently existing techniques.
Materials management	In accordance with the regulatory requirements¸ all radioactive wastes and spent nuclear fuels shall be stored in facilities approved by AEC until final

and site release	disposal sites is available. In accordance with Enforcement Rules for the Implementation of NRFRA, the radiation doses in the post-decommissioned site of nuclear reactor facility shall comply with the following limits: 1. For the restrictive use, the annual dose equivalent exposure to the general public shall not exceed 1 mSv. 2. For the non-restrictive use, the annual dose equivalent exposure to the general public shall not exceed 0.25mSv.
Stakeholder participation and knowledge management	1. Stakeholders will be involved through the normal EIA process. 2. TPC is trying to develop a" Decommissioning Information Management System (IMS)". This system is presented in the figure below. 
Topical Session(2015): Preparation for Decommission-ing during Operation and after Final Shutdown	At present, TPC is preparing the Decommissioning Plan (DP) and the Environmental Impact Assessment (EIA) of Chinshan NPP, and will be submit DP to Atomic Energy Council (AEC) and EIA to Environmental Protection Administration (EPA) before 1, Dec. 2015. AEC has organized a reviewing working group, ready to review TPC's DP. The reviewing period will last within 2 years.

Country Update on Decommissioning – WPDD 16
November 2015

Country: Czech Republic

Current status

In the Czech Republic there are two NPPs in operation: Dukovany NPP with four reactor units of VVER 440/213 and Temelín NPP with two reactor units of VVER 1000/320. Taking into account anticipated 40-year operation (i.e. lifetime extension), the expected shutdown dates for these units are between 2025-2028 and 2042-2043 respectively. Both plants are operated by the ČEZ, a. s.

Strategic Areas	Issues
Policy, regulation and strategy	**Policy and regulation** The legal and regulatory framework of decommissioning is essentially given by the Act No. 18/1997 Coll., on peaceful utilization of nuclear energy and ionizing radiation, as amended (Atomic Act), and by regulations issued by the SÚJB (i.e. State Office for Nuclear Safety) namely the decree No. 185/2003 Coll., on decommissioning of nuclear installation or workplace of category III or IV and the decree No. 307/2003 Coll., on radiation protection. The Atomic Act defines requirements on preparation of decommissioning documentation at various stages of NPP lifetime (i.e. siting, construction, first loading of nuclear fuel into reactor, operation, execution of an individual decommissioning stage) and stipulates financial requirements for decommissioning. Decree No. 185/2003 Coll., regulates the method and scope of decommissioning and specifies a content of the documentation on the proposed method of decommissioning (i.e. content of decommissioning plan) to be approved by SÚJB. Furthermore, the decree sets down the definitions of decommissioning activities and requires the regular updating of the decommissioning plans and related decommissioning costs (every five years). The latest updates of the decommissioning plans for the NPP Dukovany and the NPP Temelín have been published in May 2013 and in December 2014, respectively. **Strategy** With reference to the Atomic Act, decommissioning of a nuclear installation is one of the activities associated with utilization of nuclear power while decommissioning is defined as the set of activities aimed at releasing of nuclear installations or workplaces where radiation practices were performed, for their utilisation for other purposes. Regulatory arrangements allow the licensee to propose a strategy - deferred dismantling, direct dismantling, etc. The

	licensee shall ensure adequate nuclear safety and radiation protection.
Funding and costs	Operator of both NPPs creates statutory reserve for the decommissioning of nuclear installations. As required by the Atomic Act, the reserve is based on estimated costs of decommissioning using a procedure approved by SÚJB and by Radioactive Waste Repository Authority (acronym RAWRA). RAWRA annually provides the monitoring of the financial reserve for decommissioning and approves any withdrawal of financial means from the reserve (blocked account). Financial means may be used only for the preparation and implementation of decommissioning. Since 2008, financial means can be invested in the government securities (public bonds). The latest updates of the decommissioning costs for the NPP Dukovany and the NPP Temelín have been published in May 2013 and in November 2014, respectively.
Techniques and Innovation	In the current decommissioning plans for both NPPs it is considered dismantling of the reactor pressure vessels incl. reactor internals. To support this strategy, special projects were oriented on the description of the reactor radiation characterization after shut-down (calculation of the pressure vessel, reactor internals and biological shielding activity). Based on this calculation, the data about waste streams coming from dismantling those components were obtained (waste has been classified into three categories according to the further waste management: for release into environment, to be disposed of in the regional repository and to be disposed of in a deep geological repository). In 2015, a project dedicated to preparation of safety assessment and safety analysis for decommissioning of NPPs has been launched.
Materials management and site release	**Materials management** **Radioactive waste** When developing radioactive waste management plan, relevant operational experience is taken into account. It is assumed that radioactive waste resulting from the decommissioning process will be processed by the standard field proven technologies which are currently used in NPP Dukovany and NPP Temelín (bitumenization, immobilization in geopolymeric matrix, low-pressure compaction). Other used waste processing technologies as incineration, cementation, high-pressure compaction are considered as well in the current decommissioning plans. Radioactive Waste Disposal Facility Dukovany is available for disposal of the operational and decommissioning waste originated by nuclear power plants, therefore decommissioning radioactive waste volumes can be estimated based on their acceptability to this disposal site. The quantity of radioactive waste fulfilling the waste acceptance

	criteria (WAC) for disposal in RAW Disposal Facility Dukovany as specified for the NPP Dukovany decommissioning process is 6,000 m^3; for NPP Temelín this quantity is estimated at 4,400 m^3. Waste not complying with the WAC for disposal in RAW Disposal Facility Dukovany (i.e. internal parts of reactors) will be disposed of in a deep geological repository which should be commissioned after 2065 (estimated quantity approx. 3,000 t). Construction of the deep geological repository is in line with the national policy for radioactive waste and spent fuel management approved by the Czech government in 2002 and amended in 2012. **Inactive or slightly contaminated material** Clearance of the solid material from the controlled area is based on the limit of collective effective dose of 1 Sv/y and the limit of an effective dose to individuals 10 µSv/y. **Site release** It is assumed that both sites will be released without any radiological restriction after demolition of the active buildings. If a radiological restriction (i.e. residual contamination) remains on the site the licensee shall ensure adequate level of radiation protection and implement the on site monitoring programme.
Human and organisational factors	The decommissioning plans contain a separate chapter dealing with organisational preparations and human resources required for decommissioning activities. Due to the duration of the decommissioning process it is planned to rely more on “in-house” project management resources at the beginning of the decommissioning. Operational personnel will be particularly engaged in all activities performed after termination of operation (i.e. decontamination, spent fuel management, radwaste treatment). During the safe enclosure stage, the number of personnel will decrease. This fact will have an influence on the employment rate in the region, so that is one of important things to be solved in co-operation with regional authorities. A number of specialists will be engaged to perform dismantling and demolishing activities after safe enclosure. For this stage it is envisaged to have greater reliance on the contracting parties.
Stakeholder participation and knowledge management	**Stakeholder participation** Involvement of the stakeholders in the licensing procedures for decommissioning projects is embodied in Czech legislation - Act No. 100/2001 Coll., on environmental impact assessment. This Act requires a detailed assessment of a wide range of factors including impact on amenities, landscape, noise, transport provisions, accidents and waste management on the environment. Implementation of the environmental impact assessment, as specified in the Atomic Act, is a prerequisite for the issue of the decommissioning license granted by SÚJB. A stakeholder can participate in the process of environmental

	impact assessment namely in written statement to the documentation on environmental impact evaluation and in having respect to public opinion when processing review of the documentation on environmental impact evaluation. Also within a public hearing when the review content is being openly discussed and public opinion, including citizens initiatives and juries about documentation on environmental impact evaluation, is respected. A review maker, determined by the authority responsible for environmental impact evaluation, is obliged to assume a point of view to all the comments to the documentation. Protocol of the public hearing and review of the documentation serve as a basis for the appropriate authority to issue its position. **Knowledge management** Decommissioning plans are being prepared with support of a multi-task team, consisting of experts from the Procurement Division and Production Division of ČEZ, whose knowledge and experience may be used during the decommissioning preparation. From the organization viewpoint the team is made up of representatives from the Economics, Central Engineering and Safety departments. The team deals with technical, financial, investment and organizational issues of the decommissioning, including provision of the appropriate human resources. Appointing of the team and all activities carried out in this area, have been in compliance with the quality assurance requirements adopted by ČEZ, a. s., and established in the quality assurance program for nuclear activities.
Topical Session (2015): Extended and Deferred Decommissioning	Decommissioning plans for NPP Dukovany and NPP Temelín are based on the strategy of deferred dismantling with implementation of safe enclosure period of active buildings followed by demolition. The plans were developed in accordance with valid Czech legislation and were approved by SÚJB. The main scope of decommissioning activities like decontamination, dismantling, demolition of active buildings (i.e. the nuclear island) and RAW processing will be realized after implementation of the safe enclosure period (app. 40 years). According to the current strategy, it is considered that both sites will be released for unrestricted use (in 2086 and in 2091, respectively). With reference to the Atomic Act, the decommissioning process will be divided into several stages. Each decommissioning stage shall be subject to approval by SÚJB. In case of safe enclosure period (stage) it is assumed that a licence will be terminated at latest after 10 years and a licensee shall apply for its renewal.

16th Meeting of the Working Party on Decommissioning and Dismantling (WPDD) on 23-25 November

Country Update on Decommissioning

(Agenda Item #12.b)

Country: FINLAND

Strategic Areas	Issues
Policy, regulation and strategy	The national policy on decommissioning is defined in the Nuclear Energy Act 11.12.1987/990 section 6 a: "Nuclear waste generated in connection or as a result of use of nuclear energy in Finland shall be handled, stored and permanently disposed of in Finland." Utilities have to update the decommissioning plans of NPP's for regulatory review every six years. Decommissioning strategies for NPP's in Finland are listed below: <u>Fortum/Loviisa NPP:</u> Immediate dismantling after 50 years of operation. Spent fuel storage remains on site after the plant is decommissioned until all spent fuel is transported to Olkiluoto for final disposal. The latest decommissioning plan update was made in 2012. The next update will be in 2018. <u>TVO/Olkiluoto NPP:</u> Deferred dismantling for operating units OL1 and OL2. Immediate dismantling for OL3. Dismantling of all units is expected to be done in one campaign. The latest update was made in 2014. <u>Others:</u> Technical Research Centre of Finland (VTT) currently operates Triga Mark II 250 kW research reactor, called FiR 1. In 2012 VTT made a preliminary decision for closure of the reactor, hence the primary user of the reactor stopped the use of reactor. The final application for the closure and dismantling is still pending. In autumn 2013 VTT started the environmental impact assessment (EIA). EIA is the first step for the decommissioning of the facility. EIA report was established in late 2014 and Ministry of Employment and the Economy made the statement in 25 February 2015. VTT was decided to shutdown the reactor permanently in June 2015. The decommissioning strategy of the reactor is immediate dismantling with a few years from the permanent shutdown

	of the reactor. The spent fuel return option to the fuel manufacturer in United States (DOE) is valid until 2019. The decommissioning and dismantling of the FiR is the first nuclear facility decommission in Finland. The whole process will be under regulatory review and inspections by STUK.
Funding and costs	Annual payments to Nuclear Waste Management Fund operated by the government.
Techniques and Innovation	In the Fortum/Loviisa NPP and TVO/Olkiluoto NPP reactor pressure vessels are planned to be dismantled as one piece. All decommissioning plans in Finland are based on currently existing techniques. Fortum's NURES nuclide removal system will be used for cleaning water from the systems, pools and tanks before dismantling work begin in Loviisa NPP. This allows free release of water and lowers the volume of waste to be solidified and disposed of as radioactive waste.
Materials management and site release	In the Fortum/Loviisa NPP and TVO/Olkiluoto NPP final disposal to the extension of the existing geological LILW repositories at the NPP sites. Sites released for further industrial site.
Human and organisational factors	<u>Fortum/Loviisa NPP:</u> The plant personnel will form the basis of the decommissioning organization. Subcontractors will be used in dismantling work. The organizational structure is described in the decommissioning plan. <u>TVO/Olkiluoto NPP:</u> The planned organization for D&D is presented in the decommissioning plan.
Stakeholder participation and knowledge management	<u>Fortum/Loviisa NPP:</u> Stakeholders will be involved through the normal licensing process for decommissioning and extension of the LILW repository. This process includes e.g. EIA with public hearings. <u>TVO/Olkiluoto NPP:</u> Company's normal database and archiving systems are used also for D&D purposes.
Topical Session (2015): Extended and Deferred Decommissioning'	

16th Meeting of the Working Party on Decommissioning and Dismantling (WPDD) on 23-25 November 2015

Country Update on Decommissioning

(Agenda Item #12.b)

Country: Germany

Presenter: Bernd Rehs

1.) Status Report

In Germany, 28 nuclear power plants (NPPs) and prototype reactors have been permanently shut down. Three of them (KKN in Niederaichbach, HDR in Grosswelzheim and VAK in Kahl) have been completely dismantled. The sites have been restored to "green-field conditions" and are released from nuclear regulatory control. Two of the NPPs (KWL in Lingen and THTR-300 in Hamm-Uentrop) are in safe enclosure. For 14 NPPs the dismantling is in progress with "green-field conditions" being the planning target. For 8 NPPs the authorizations for power operation expired in the year 2011 and they have been permanently shut down. Additionally, NPP Grafenrheinfeld was permanently shut down on 27 June 2015.

Applications for decommissioning and dismantling of the permanently shut down Unterweser NPP (PWR 1410 MWe) and Isar 1 NPP (SWR 912 MWe) were filed on 4 May 2012. For the permanently shut down Biblis NPP Unit A and Unit B (Unit A: PWR 1225 MWe, Unit B: PWR 1300 MWe) applications were filed for the decommissioning and dismantling of the plants on 6 August 2012. For the permanently shut down Brunsbüttel NPP (SWR 806 MWe) an application for decommissioning and dismantling was filed on 1 November 2012. On 24 April 2013, applications for decommissioning and dismantling were filed for the permanently shut down Neckarwestheim 1 NPP (PWR 840 MWe) and for Philippsburg 1 NPP (BWR 926 MWe). For the permanently shut down Krümmel NPP (BWR 1.402 MWe) an application for decommissioning and dismantling was filed on 24 August 2015. For the permanently shut down Grafenrheinfeld NPP (PWR 1345 MWe), an application for decommissioning and dismantling was filed already on 28 March 2014. An application for dismantling was posted well in advance on 11 December 2014 for the NPP Gundremmingen B (BWR 1344 MWe) in power operation, whose set end-date is 31 December 2017.

Up to now for 29 research reactors decommissioning was finished and they have been released from nuclear regulatory control. Two research reactors are in safe enclosure. Dismantling of 8 research reactors is either in progress or in preparation.

Furthermore 11 nuclear fuel cycle facilities (mostly fuel fabrication and fuel reprocessing facilities) have been permanently shut down and for 10 of them decommissioning was finished and they have been released from nuclear regulatory control. Dismantling is in progress for the Karlsruhe Reprocessing Plant (WAK) including the associated vitrification facility.

2.) Topic-specific information

Strategic Areas	Issues
Policy, regulation and strategy	Policy: As a consequence of the nuclear accident at the NPP Fukushima Daiichi, on 11 March 2011 in Japan, the German legislator decided to phase out the use of nuclear power for the commercial generation of electricity on a step-by-step basis by the end of the year 2022 at the latest. Therefore the German Atomic Energy Act was amended and entered into force on 6 August 2011. Regulation and Strategy: In Germany, the legal bases for the licensing procedures involving the decommissioning of nuclear facilities are the Atomic Energy Act (Atomgesetz – AtG), the statutory ordinances on the basis of the AtG, as well as general administrative provisions. A whole range of codes and guidelines of a predominantly technical nature exists below the level of laws and ordinances on the so-called sublegal level. For any installation the decommissioning, safe enclosure or dismantling of that installation or of parts thereof shall require a licence. The competence for granting, cancelling or withdrawing a licence lies with the regulatory body which is the respective Federal Land ministry responsible for nuclear regulations. The work authorised by the decommissioning licence is supervised by the relevant regulatory body of the Federal Land. For the recommendation “Guidelines for the decommissioning of nuclear facilities” of the Nuclear Waste Management Commission (ESK – Entsorgungskommission, November 2010) a review by the ESK started in 2014 and the recommendation was republished in March 2015. For the Decommissioning Guideline of the year 2009 a review was conducted in 2015 by the Working Group on Decommissioning, composed of representatives of the Federal Government and the Länder. As of October 2015, the amendment process is in an advanced stage, but formally not completed.
Funding and costs	In accordance with legal requirements, the operators, whether private or public, have to cover the costs for the decommissioning of their nuclear facilities and the disposal of the resulting radioactive waste. The private operators (NPPs) have to estimate these costs and accumulate the respective funds during operation. Research reactors and nuclear facilities of the former German Democratic Republic (GDR) like NPPs at Greifswald and at Rheinsberg are in hands of a public organisation and the costs for their decommissioning and the disposal of the associated waste are borne by public funds within the annual budget.

	In October 2015 the Federal Government has decided a draft legislation on additional liability for decommissioning and disposal costs, assuring the long term accountability of the electric power companies. Additionally, a commission shall review the funding for decommissioning and disposal.
Techniques and Innovation	Today, there is a large number of tried and tested technologies available for decontamination and dismantling of facilities or parts of facilities. The operational safety, the emission behaviour and applicable measures for radiation protection of workers as well as costs for it are known.
Materials management and site release	Clearance and Site Release: In Germany quantitative requirements for the release of materials, buildings, and sites from nuclear regulatory control were introduced into the Radiation Protection Ordinance (StrlSchV, § 29) in the year 2001. The radiation protection legislation is currently under revision in order to implement council directive 2013/59/Euratom into German law. Materials Management: Only a small fraction of the materials of a nuclear facility come into contact with radioactive substances or are activated by neutrons. Most of the contamination can be removed by appropriate decontamination techniques. The same boundary conditions apply for the collection, sorting, conditioning and documentation of radioactive decommissioning waste as for operational waste. If, in particular, contaminated and activated metal parts, for which the nuclide vector indicates a decay of the activity within a foreseeable period of time so that the material can be cleared by measurements or reused in nuclear technology, later utilisation is given preferential consideration instead of disposal. A reduction in the volume of the radioactive waste may be reached or unnecessary radiation exposure avoided by decay storage of radioactive non-segmented large components. For the storage of radioactive waste from operation and decommissioning and radioactive residues for decay storage, construction and operation of an on-site storage facility can be applied for which can be integrated into residual operation during decommissioning and dismantling but after dismantling of the facility it has to be further operated autarkic with a separate licence. In this context adequate documentation of the radioactive inventory, dose rates, material composition, origin and demonstration of long term stability must be created and preserved at least until the end of storage. Disposal: The former Konrad iron ore mine located near the city Salzgitter in Lower Saxony / Germany will be converted into a repository for radioactive waste with negligible heat generation.
Human and organisational factors	The operator must ensure that an adequate number of appropriate staff with the required qualification and knowledge is available in all phases and periods of the decommissioning

	procedure until release from nuclear regulatory control. The use of internal personnel as responsible persons has proved itself regarding continuity of staff. The persons who are responsible must have the necessary technical qualification. The organisational structures which are necessary to guarantee the safety requirements must be in place. Other individuals involved in the decommissioning measures must possess the necessary knowledge. In addition, it must be ensured that in all cases of personnel changes, even in the event of a possible change in licensee, all of the documentation relating to the actual status of the facility is completely transferred and retained so that no significant knowledge about the facility will get lost.
Stakeholder participation and knowledge management	Stakeholder participation: An Environmental Impact Assessment (EIA) is part of the licensing procedure for the first decommissioning licence and reviews the whole range of impacts of a given project on the environment. The EIA includes an announcement and disclosure of the project for public inspection. All objections submitted in time shall be discussed by the licensing authority with the applicant and the persons by whom the objections are raised (hearing). As a rule, all federal, Länder, local and other regional authorities whose jurisdiction is involved shall take part in the licensing procedure. Knowledge management: The measures carried out during decommissioning are documented in accordance with the terms of the decommissioning license. After completion of all decommissioning work, the operator should prepare a final decommissioning report and keep it together with the documentation.
Topical Session (2015): Extended and Deferred Decommissioning'	The Atomic Energy Act and the German legal regulations consider the decommissioning strategies "direct dismantling" and "safe enclosure" to be equivalent. It is the decision of the operator which decommissioning strategy shall be applied. In Germany, direct dismantling is mainly practised so far. Also for the future decommissioning projects having applied for decommissioning and dismantling so far, direct dismantling is the chosen strategy.

16th Meeting of the Working Party on Decommissioning and Dismantling (WPDD) on 23-25 November

Country Update on Decommissioning

(Agenda Item #12.b)

- Country: ITALY

Presenter: Mr. Tripputi, Mr. Trenta

Strategic Areas	Issues
Policy, regulation and strategy	Policy The national policy calls for one step decommissioning to be terminated with the unconditional release of the sites. In the wait of a national repository commissioning, the decommissioning strategy up to the unconditional release of the sites is maintained (green field), envisaging an intermediate phase (brown field) characterized by the interim storage of waste on the site. Regulation On the basis of the Legislative Decree n. 45/2014, wich is the transposition of Europen Union Directive 2011/70/Euratom, on 7 august 2015 an Economic development and Environmental Ministry joined Decree was issued about a new radioactive waste classification according to IAEA recommendations. Strategy The implementation of siting procedure for LLW/ILW national repository is in progress.
Funding and costs	Legislative Decree n. 45/2014 establishes that part of the budget of the NSA will derive from fees fixed by NSA and paid by the Licensees.
Techniques and Innovation	ISPRA has conducted some research studies for verifying Box Counter instrumentation used for clearance.
Materials management and site release	Clearance levels for NPPs under decommissioning are given in the decommissioning licenses which are established taking also into account European Union Directives and recommendations. The development of a NSA “ad hoc” Technical Guide is in progress.
Human and organisational factors	The structural organization of the new NSA (ISIN) foresees the assignment of 60 units of technicians. This organization process envisages also that part of the budget of the NSA will derive from fees paid by the Licensees, and it is expected that this should allow the

	NSA to have access to additional human resources. In November 2016 Integrated Regulatory Review Service (IRRS) visit will be hosted by NSA.
Stakeholder participation and knowledge management	The Conference of Services involving Ministry of Economic Development, Region, local community and the operator, for the authorization for a new Radwaste at Latina NPP, has been concluded.
Topical Session (2015): Extended and Deferred Decommissioning'	In 1987, after a public consultation in the aftermath of Chernobyl accident, all three operating NPP's (one was already stopped by ENEL for economic reasons) were not allowed to restart. Later the Government decided to shut them down definitely. In the '90ties ENEL started to implement preliminary actions for their decommissioning, adopting in this phase the SAFESTOR strategy, for several reasons, including the fact that the accumulated funds were not sufficient for a prompt decommissioning. At the end of 1999 the Government asked for a DECON strategy, while in 2001 a funding mechanism was defined in the law to complement the ENEL funds. Sogin, a company fully owned by the Italian Government was charged with the mandate of proceeding with decommissioning of the four NPP's and later also of the decommissioning of the fuel cycle facilities. Sogin had to face the challenges of keeping and using the operating staff, which had to be retrained for decommissioning activities and to completely review the decommissioning plans from SAFESTOR to DECON. At the same time status and cultures of various nuclear installations required harmonization of the approached and practices in the new decommissioning operating mode. Another difficulty in proceeding with decommissioning was the lack of a national repository at least for LILW and the related Waste Acceptance Criteria. This fact obliged Sogin to plan and build waste interim storage facilities in all sites, where the waste was stored in unconditioned state. Sogin had also to optimize schedule and resources in all eight sites. Knowledge building and flattening of the financial and man-power resources may not lead to the shortest decommissioning schedules in all sites. Optimization of various factors may lead to a longer overall schedule, while at the end the additional fixed costs may be compensated by a more regular overall process and by a greater competence building. The same applies also to the best use of regulatory resources and of the licensing processes.

Country Update on Decommissioning (WPDD 2016)

(Agenda Item #12.b)

Country: Republic of Korea (ROK)

Strategic Areas	Issues
Policy, regulation and strategy	**o Decommissioning Policy** - Kori unit 1, the first commercial NPP in Korea, to be shutdown permanently in 2017 - Nation plan to promote domestic nuclear industry and develop relevant innovative technologies by AEPC, Oct.5, 2015 (which is a pan-governmental strategy and policy for technologies development and fostering nuclear industry in line with its plan for a safe and cost effective Kori-1 decommissioning) - 10-year life extension of Wolsong unit 1 to 2022. **o Regulation and strategy** - Nuclear Safety Act (NSA) and relevant regulations for decommissioning have been revised and effective in July, 2015. · Initial Decommissioning Plan (IDP) at the construction permit and operating license stage of NPP and its update at every 10 years during operation. - Classification of RW and standards for clearance as the Notice of NSSC No. 2014-03 (Sept., 2014). · less than 10 μSv/y and less than 1 man· Sv/y · radionuclide specific concentration criteria (more than 250 nuclides) - NSSC's preparation of the site release criteria for unrestricted or restricted use of nuclear facility site - Renew of RW acceptance criteria by MOTIE (May 2015)
Funding and costs	o Accumulated decommissioning cost: ~ 9,000MUSD (as of June, 2015) o Base of the estimation of NPP decommissioning cost: ~600MUSD per unit.
Techniques and Innovation	o Development of 34 key and core decommissioning technologies to commercialize for NPP decommissioning and establishment of by 2021 under support of MOSIP and MOTIE o NRF's preparation of 5th National Nuclear R&D program (2017-2021)
Materials management and site release	o KORAD's LILW repository (cavern type) under operation since December 2014. - 1st emplacement of waste package in July 2015 - 2nd LILW repository(shallow land disposal type) plan in 2021 o KAERI's preparation for the site release of research reactor unit 1&2 dismantled from 1997 to 2013.
Human and organisational factors	
Stakeholder participation and knowledge management	o KAERI's development of DPMIS from 2015 to 2017 at the base of RR decommissioning project. o According the revision of NSA, the licensee shall submit the final decommissioning plan(FDP), QAP for decommissioning, and public consultation records for approval application of decommissioning. - gathering the resident's opinion
Topical Session (2015): Extended and Deferred Decommissioning'	

16th Meeting of the Working Party on Decommissioning and Dismantling (WPDD) on 23-25 November

Country Update on Decommissioning

(Agenda Item #12.b)

Country: **Slovakia**

Presenter: **Mr. Miroslav Drahos**

Current status

The actual decommissioning program in Slovakia consists with three ongoing decommissioning projects. Decommissioning of a HWGCR type of reactor KS- 150 (A1 NPP) shutdown in 1977 after primary coolant system integrity accident with local melting of the fuel; decommissioning of two (so called twin units -two reactors in one reactor building with a common reactor hall) VVER 440 reactors of V-230 (V1 NPP) shut down in accordance with the Governmental resolution in 2006 and 2008 respectively and decommissioning of two experimental nuclear facilities – a bituminisation line; and an incinerator for RAW owned by VUJE Plc installed in the premises of NPP A1 in Bohunice. Meanwhile the incineration facility was released from nuclear regulatory control last year.

Strategic Areas	Issues
Policy, regulation and strategy	The National Policy and National Programme for the management of spent fuel and radioactive waste that update the existing national “Strategy of the Back End of the Nuclear Power Sector” was approved by Governmental decision No. 387/2015 taking into consideration the transposition of the European Council Directive 2011/70/EURATOM establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste. This Directive was transposed by the amendment of atomic act No. 143/2013 Coll. One of the principles the National Policy is based on is following: “The Slovak Republic has the ultimate responsibility for the decommissioning of nuclear installations located in Slovakia, for the safe and responsible long-term storage and disposal of spent nuclear fuel and for the radioactive waste management, which has been produced on its territory after its takeover from the producer”. The basic technical aspects of national decommissioning strategy remains the same, e. g. continuous decommissioning option is used for decommissioning of the A-1 NPP up to 2033 and immediate decommissioning option is used for decommissioning of VVER type reactors, total decommissioning time less than 20 years.

Funding and costs	Decommissioning activities are generally financed by Act on National Nuclear Fund for Decommissioning of Nuclear Installation and for Management of Spent Nuclear Fuel and Radioactive Waste (Act on NNF). The NNF is an independent legal entity, which is managed by the Ministry of Economy. The Fund has its own bodies (council of administrators, supervisors board, director, managers of subaccounts, auditor). The sources of the NN F are various – contributions paid by the licensees for operation of nuclear facilities, charges collected by the operators of the transmission and the distribution systems in the prices of supplied electricity directly from end customers (serving for compensation of the so called "historical debt"), fines imposed by UJD SR, interests earned on deposits, subsidies and contributions from the EU, from the state budget, and other. Decommissioning of the A1 NPP is fully financed by the Act on NNF. Some projects related to decommissioning of the V1NPP are co financed by Bohunice International Decommissioning Support Fund (BIDSF). The administrator of BIDSF is the European Bank for Reconstruction and Development (EBRD). The financing of the V1 NPP decommissioning projects from the sources of BIDSF is implemented on the basis of the grant agreements, in which the framework definitions of the scope of projects and grants for financing of the individual projects are set forth.
Techniques and Innovation	No significant changes in decommissioning techniques. The actual innovative techniques are closely connected with the solution of the NPP A-1 operational/historical waste treatment (chrompic – water solution of potassium bio chromate, dowtherm - eutectic mixture of biphenyl and biphenyl oxide) and with their sledges solidification. Radiological, chemical and physical characteristic are more complex and unique treatment facilities with sufficient capacity have been developing. Due to high level of contamination and dose rate in some structures of A1 NPP many operations must be performed remotely and therefore adequate techniques have been developed and modelling and simulations techniques are used (3Dipsos software, SOISIC" scanner, 3D Laser-Scanner CALLIDUS CP 3200). All operational radioactive wastes from the V-1 NPP (radioactive organic sorbets and sledges, liquid radioactive concentrates) are already solidified and usage of actual decommissioning techniques relates to the decontamination of the primary circuit (DFD decontamination process) to perform pre-dismantling chemical decontamination of primary circuits of both V1 NPP units.

Materials management and site release	Currently 2nd stage of the A1 NPP decommissioning project is in progress. The activities of 2nd stage concentrate on decontamination and demolition of external structures of the A1 NPP, on the problems related to the management of contaminated soil and concrete rubble and on the management of radioactive waste from the main production compound of the A1 NPP. Contaminated soils are sorting at workplace (transportable autonomous device with belt conveyer monitor and contaminated soil sorting system) that works in modes of sorting, monitoring or releasing of sorted soils. Contaminated soil and concrete rubble of activity less than 10 kBq/kg are stored in bags called "BigBag" at the premises of A1 NPP before they will be transported for final disposal on the very low radioactive waste repository (VLLW). The VLLW repository is intended for disposal of concrete debris and soil, which do not meet radiological criteria for their release, but they fulfil the requirements for VLLW and their treatment into FRC form would be not effective and not economically favourable. The ambition to use radioactive waste management technologies that enables to release an optimum amount of materials still remains. Therefore the melting process is still under consideration in Slovakia. Provision of release of selected objects of the A-1 NPP and the V-1 NPP at the Bohunice site from the scope of the atomic act was recently used. It should be noted that this was the first activation of these provisions of atomic act in the history of Slovakia. Main purpose for partially release of site is the preparation for the construction of a new NPP in Bohunice site realized by JESS company (a joint venture of the Slovak (JAVYS, which owns 51% share and the Czech power group, ČEZ, which owns 49% share of the company). JESS submitted the EIA Report of the proposed activity to the Ministry of Environment in recent days. The final completion of the EIA process and the issue of the final statement by the Ministry of Environment are expected in the first quarter of 2016.
Human and organisational factors	System of contractors and subcontractors has been well established during the 1st stage and 2nd stage of A1 NPP decommissioning. The general contractor approach is applied, where the decommissioning project is implemented through the plant operator JAVYS and its general contractor. In practice several suppliers' chain schemes were tested for the project activities implementation and model of general contractor was indicated as the most suitable in this case. Managing of NPP V1 decommissioning project is based on independent contract of suppliers for the individual activities. The decommissioning works are performed by more external suppliers and therefore their coordination and cooperation from side licence holder JAVYS is inevitable. The part of the NPP V1 decommissioning projects financed from BISDF is procured

	and managed by EBOR`s rules. The residual part of projects is financed from means of the NNF.
Stakeholder participation and knowledge management	The EIA regulations of the Slovak Republic are based on the EIA act. There are several amendments of this act, some of them due to specification of public involvement in the EIA process or specification of the assessment of a change of such activity that was assessed before. Council Directive 85/337/EEC on the assessment of the effects of certain public and private projects on the environment is now fully transposed. Structure and contents of most of the documents as well as the process of strong participation of effected authorities and public is provided in detail by the EIA act. The EIA is an integral part of the decommissioning licensing process. Several EIA processes were conducted recently with the connection of individual decommissioning related projects e. g. Second stage of the V1 NPP decommissioning in Bohunice site, Metallic radioactive waste remelting facility, Construction of a new high-capacity V1 NPP fragmentation and decontamination facility, Decommissioning of the A1 NPP, stages III and IV. Intensive communication with representatives of the affected municipalities and the public took place recently during the implementation of above mentioned projects through various means, e. g. meetings, leaflets, magazine, company website, consultation meetings and public hearings.
Topical Session (2015): Extended and Deferred Decommissioning'	

13th November 2015

Nuclear decommissioning issues in Sweden – Country update November 2015

Facility-specific status report

Barsebäck nuclear power plant

The two BWR units in Barsebäck, 2 x 615 MWe, were permanently shut down in 1999 and 2005, respectively, according to political decisions. The license holder and operator Barsebäck Kraft AB (BKAB) has prepared the facility for a period of care and maintenance pending dismantling (off-site shipment of fuel, downsizing of organization, adjustment of supervision and maintenance activities, energy saving measures, etc.). Primary system decontamination of both units was performed during the winter 2007-2008. Processing of the wastes from operation and system decontamination is proceeding. An extensive survey has been performed of radiological and hazardous substances in systems, buildings and the site. A 3-D model of the plant has been designed to be able to document and view the results of the mapping.

Dismantling is planned to start 2023 and the projecting of the dismantling work is planned to start 5 years before dismantling. Free release of the buildings are planned to take place during 2027 and after that conventional demolition will start. It is intended that the project will reach its final end state 2029-2030, with release of the site.

Project HINT - segmentation and interim storage of reactor internals - is ongoing in the projecting phase. The construction of the interim storage at Barsebäck NPP has started up. It is then planned that the steel containers will be transferred for further interim storage in a separate part of the national repository for low- and intermediate level waste in Forsmark (SFR), once the extension of this facility is completed. The final destination of these wastes will be the national repository for long-lived low and medium level waste, SFL, which is planned to be in operation in 2045. Contractors have been procured for the construction of an interim storage, segmentation of the internal parts and the rebuilding of the reactor halls overhead cranes. It is planned that segmentation and transfer of the internals into the new interim on-site storage is scheduled to be completed during 2019.

Studsvik material test reactors

The two material test reactors in Studsvik (one tank type and one mobile pool type) were permanently shut down in 2005. The reactors were dismantled in 2015 after approval of the safety report and waste management plan by the Swedish Radiation Safety Authority (SSM). Preparations for decommissioning of the biological shield and the remainder of the facility are ongoing. Draining of the pool is planned to start in early 2016 and the dismantling of the biological shield is planned to be undertaken 2016 to early 2017. Decommissioning of other parts of the facility is planned to be carried out in parallel with these activities. According to the current time schedule dismantling activities will continue until 2019 to achieve an end state with the facility prepared for free release.

Dismantling of the reactors has been delayed partly due to a request from the European Commission for complementary information according to the Euratom Treaty Article 37. The Article 37 report was approved by the commission in early 2013.

The license according to the Act on Nuclear Activities has been transferred from the operator Studsvik Nuclear AB to the decommissioning and waste management company AB SVAFO.

Ågesta PHWR

The pressurized heavy water reactor in Ågesta was permanently shut down 1974. Two steam generators were dismantled and waste treated in Studsvik in the early 1990s, as part of an NEA research project.

Currently, preparations are being made for radiological characterisation and planning of future decommissioning, intended to begin 2020. A license according to the Environmental Code for continued care and maintenance until 2020 was issued by the local environmental court in November 2008.

In 2009, the company AB SVAFO applied to take over the license for the Ågesta facility from the current licensee Vattenfall AB. The application has been reviewed by SSM, which gave its recommendation to the Ministry of Environment in April 2015. Aspects considered by the authority in the review of the application according to the Act on Nuclear Activities included financial provisions, adequacy of the management system and organisational capabilities of the applicant. A decision from the government is pending.

Old installations in Studsvik

Decommissioning of minor old nuclear installations in Studsvik is being performed by the licensee AB SVAFO. Two old underground silos for liquid intermediate level waste have now been decontaminated and partially dismantled. In April 2015 SSM approved AB SVAFO´s application for clearance of the remaining underground structures and the building foundation.

Some of the old waste storage facilities are currently being refurbished in order to meet the demands on waste storage capacities. Also, parts of the sewage system in Studsvik are currently being refurbished by the licensee Studsvik Nuclear AB. This includes decommissioning of parts of the systems and culverts.

Installations in Ranstad

The uranium mining and milling facilities in Ranstad were constructed and operated in the 1960s. Totally about 200 tonnes of uranium were produced. The uranium open-cast mine and mill tailings deposits were restored and covered in the 1990s.

Currently, decommissioning of the remaining facility is proceeding. Part of the facility was until 2009 used for extraction of uranium from waste originating from nuclear fuel fabrication. This license expired in December 2009 and the installations are planned to be decommissioned as a part of the decommissioning project for the leaching and extraction plant. An extensive radiological survey has been performed and detailed plans have been developed for the dismantling of remaining systems, demolition of buildings and restoration of the site.

The former mineral processing plant has been dismantled and demolished after approval by SSM. The remaining ground was inspected by the local municipality authorities according to the plan and building act in October 2013. Currently, clean-up and dismantling of plant equipment is carried out as part of the preparation for further decommissioning activities for remaining nuclear installations in Ranstad, mainly the leaching plant. Certain waste from these activities is being transported to a landfill site for hazardous waste, after clearance by SSM. According to the current plan, the decommissioning activities will continue to 2017.

Repository for short-lived low- and intermediate level waste (SFR)

The Swedish Nuclear Fuel and Waste Management Company (SKB) submitted the applications at the end of 2014 for extension of the existing SFR repository so that it also can be used for decommissioning waste. The extension is being designed to facilitate disposal of one-piece BWR-reactor pressure vessels (without internals). Also, part of the extension is planned to be used for intermediate storage of long-lived waste (mainly reactor internals) pending the construction of another repository for that kind of waste (the national waste repository for long-lived low and medium level waste, SFL). A special transport package is being developed for reactor internals. The first decommissioning waste is planned to be received at SFR in the end of 2020s.

Decommissioning preparations at facilities in operation

There are ten reactors in operation at three nuclear power plant sites in Sweden. The first of these reactors currently in operation that are planned to be decommissioned are the two oldest reactors at Ringhals nuclear power plant, Unit 1 (Asea Atom BWR) and Unit 2 (Westinghouse PWR). Both units are planned to be fully decommissioned five years after final shutdown. A separate team in Ringhals has been set up in order to handle the decommissioning planning.

Since early 2014, preparations have been underway to prepare for a future shutdown of unit Oskarshamn Unit 1 (O1, an Asea Atom PWR). In June 2015, OKG (owned by E.On and Fortum), the operator and owner of the Oskarshamn nuclear power plant submitted an application to the Environmental Court for an environmental permit enter a care and maintenance phase and conduct partial dismantling of the reactor. The time for the shutdown has not yet been established, and the purpose of the application is to obtain the environmental court ruling required in order to facilitate shutdown in an organised and timely manner, once the decision is made. OKG have stressed that the timing of the actual decision on closure would be taken exclusively based on commercial grounds. OKG anticipate that an environmental court ruling would be received around the turn of the year 2016 – 2017.

In October 2015 OKG confirmed the policy decision on the premature shutdown of O1 and formally announced the early closure of Oskarshamn Unit 2 (O2), which has been offline since 2013 due to a major upgrade. The decision entails that there will be no future investments at unit O2 and the reactor will not be restarted.

In April 2015 Vattenfall, the majority owners of the Ringhals nuclear reactors, announced its intention to consider the closure of the first two units between 2018 and 2020, some five years earlier than planned. The background to the decision was poor profitability and increased costs. In September 2015, Vattenfall further announced that investments in the two oldest Ringhals reactors would be limited, which meant that Ringhals units 1 and 2 would be in operation until 2020 at the latest. In mid-October 2015, it was formally decided to end operation of Ringhals 2 in 2019 and Ringhals 1 in 2020, in connection with the yearly outages. Vattenfall develops plans to organise the decommissioning of its nuclear power plants in a separate business unit.

The remaining six nuclear power reactors in Sweden plan for a total operation time of 60 years, meaning that the last unit will start decommissioning in 2055.

In 2013, the operators presented updated decommissioning plans for all the operating nuclear power plants. The plans have been reviewed by SSM and the authority found shortfalls with the plans that will have to be addressed by the operators. This process will continue during 2016.

Topic-specific news

Policy, regulation and strategy

SSM is currently making changes to its regulations concerning nuclear safety and radiological protection, including waste management and decommissioning. SSM is also reviewing the applicable legislation in order to propose amendments to the Government.

Funding and costs

Cost estimates for waste and decommissioning, which included site-specific decommissioning studies for all the Swedish power reactors were reviewed by SSM as a basis for the authority's recommendations to the Government in 2014 on waste and decommissioning fees for the coming three year period (2015-2017). In December 2014 Swedish Government accepted the proposals from SSM that the waste and decommissioning fee level be raised from about 2.2 Swedish cents (ca € 0.002) per produced kilowatt hour (kWh) to an average of 4,0 Swedish cents (ca € 0.004) per kWh. (A separate flat fee applies for the permanently closed reactors at Barsebäck.) The reason for the fee increase was mainly falling interest rates. Also, the future performance of the nuclear waste fund is expected to be low and the contributions paid will be lower than earlier forecasts. The expected costs of decommissioning and disposal as reported by industry, has also increased.

Since part of the basis for the calculation of fees is the expected future production of electricity from nuclear generation, the above fees may need to be further reviewed in light of the planned early closure of the reactors described earlier.

Techniques and innovation

There are no specific developments in this area to be reported for the period.

Materials management and site release

The option of shallow land burial of very low level decommissioning waste has been investigated by SKB in a feasibility study. Shallow land burial was evaluated together with other dispose routes in order to find an optimized approach. The identified amount of decommissioning waste is recommended to be disposed of in the SFR facility. Further studies are being planned and are ongoing in this area.

A project initiated by the Swedish nuclear industry to develop a handbook for adoption of the clearance process during decommissioning and site release has been finalised. The work has been led by the SKB together with BKAB, in cooperation with the other Swedish nuclear facility operators. In parallel, SSM is currently developing regulations for site release.

SKB has started a pre-study to identify probable alternatives where VLLW can be used conventionally for specific waste treatments or in other applications. In step two of the pre-study, dose calculations for the scenarios will be performed. The report will summarise and present optimal routes for the VLLW to be treated conventionally, supported by dose calculations and justifications from an environmental and economical point of view.

Human and organisational factors

There are no specific developments in this area to be reported for the period.

Stakeholder participation and knowledge management

In connection with preparations for future shutdowns of reactors at Oskarshamn and Ringhals, the operators have conducted stakeholder consultations related to the closure of reactors and the permit applications to the Environmental Courts.

An updated database for documentation related to decommissioning has been constructed by SKB together with the Swedish nuclear industry in order to archive and exchange information. The database is structured according to the ISDC-structure and enables it to be used as a knowledge management tool.

16th Meeting of the Working Party on Decommissioning and Dismantling (WPDD) on 23-25 November

Country Update on Decommissioning

(Agenda Item #12.b)

Country: **Switzerland**

Presenter: **Hannes Hänggi, ENSI**

Strategic Areas	Issues
Policy, regulation and strategy	After the Fukushima accident 2011, the Federal Council and the Swiss Parliament decided to phase out nuclear energy by abandoning the building of new plants, but the existing plants (five reactors on four sites) should continue to operate as long as they are safe. In October 2013, the energy company BKW Energy Ltd decided to shut down its Mühleberg NPP in 2019 due to economic reasons. The Swiss regulatory systems prefers immediate dismantling as decommissioning strategy. Hence, BKW Energy Ltd is planning to begin with the first preparatory activities for decommissioning immediately after final shutdown in December 2019. The final decommissioning plan will be submitted to the authorities by the end of 2015. The licensing authority (Federal Department of the Environment, Transport, Energy and Communications, DETEC) wants to grant the decommissioning order, which replaces the operating license, before the final shut down of the Mühleberg NPP. The requirements for the final decommissioning plan are described in • Nuclear Energy Act • Nuclear Energy Ordinance • ENSI's technical guideline G17 Since October 2015, ENSI's decommissioning guideline G17 is available in English and can be downloaded on ENSI's webpage. The guideline is in accordance with the WENRA Safety Reference Levels and the respecting IAEA Safety Standards on decommissioning. In April 2015, IAEA conducted the Integrated Regulatory Review Service (IRRS) follow-up mission to Switzerland. The initial mission took place in November-December 2011. The purpose of this peer review was to review the measures undertaken following the recommendations and suggestions of the 2011 IRRS mission. On the field of decommissioning, there were two

	suggestions of the 2011 mission: • ENSI should continue to be an active participant in the IAEA and other international decommissioning forums to gain valuable regulatory experience for the decommissioning of the Swiss research and power reactors. • ENSI should develop a human resources plan for providing inspectors and other technical specialists required to regulate reactor decommissioning projects and to ensure end point criteria are met for terminating the licences. ENSI could show, that it has created a new decommissioning section and increased staff to provide regulatory focus on decommissioning and allow for participation at international forums. Further on, ENSI has completed an internal management review of the decommissioning program comprehensive needs that includes organization, human resources, regulatory assessment and advanced training needs. Both suggestions are now closed. There are no further observations by the IRRS follow-up mission. In July 2014, DETEC granted the decommissioning order for the Pilot Incinerator Plant (VVA) at the Paul Scherrer Institute (PSI). After some preparatory activities, such as the construction of a new ventilation system and an annexe to the building for the waste treatment, the dismantling activities are likely to begin in January 2016.
Funding and costs	The Ordinance on the Decommissioning and Waste Management Funds for Nuclear Installations has been revised twice. The first revision became legally binding by the beginning of 2015. The main change within the revised ordinance is a general extra amount of 30 percent to the cost estimates for the decommissioning and the waste disposal funds. These 30 percent increase of course the annual contributions to the funds that the operators of nuclear power plants have to pay. That is the reason why the licensees object these 30 percent contingency. The second revision of the ordinance will become legally binding by the beginning of 2016. The new revision respects mainly aspects of governance. In course of this revision, ENSI already resigned from the cost committee of the funds. Thus, to strengthen its independence with regard to the review of the decommissioning plans and technical aspects of the cost studies 2016. The funds themselves are well stocked. The amount of required contributions to the Disposal Fund is based on the anticipated disposal costs, which according to the current calculations will be approximately 16 billion Swiss francs (pricing basis, 2011). As of the end 2014, 5.3 billion Swiss francs had been spent (e.g. for

	research and preparatory tasks, reprocessing of spent fuel elements, construction of a central interim storage facility, acquisition of transport and storage containers). Another portion (amounting to 2.2 billion Swiss francs) will be required from 2014 until the time of decommissioning, and this amount has to be covered by the operators on an ongoing basis. The fund thus has to secure 8.4 billion Swiss francs, of which about 3.68 billion Swiss francs are already payed into the funds.
Techniques and Innovation	The decommissioning of Mühleberg NPP will be a first of its kind project: Immediately after final shutdown, the operator (BKW Energy Ltd) plans to begin with some preparatory dismantling activities still with spent fuel on site (in the spent fuel pool). The planned activities include the cutting of concrete shielding, the RPV internals and the removal of the turbines. According to the plans of BKW, this will reduce the time for decommissioning to about 14 years. The review of the final decommission plan by ENSI will show, if BKW's approach is safe and can be approved.
Materials management and site release	The revision of the Radiological Protection Act is under way. The main change in the act will be decreased clearance levels. As a result, decay storage of LLW will become an option in the decommissioning projects. It is not decided yet, whether there will be a central decay storage or if every site will have its own decay storage. Actually, decay storage is already respected in the decommissioning projects at PSI site.
Human and organisational factors	In regard of the future decommissioning, the operators of NPP's have to implement a human resources development plan. BKW elaborated its own HR plan this year in more detail. According to the Swiss legislation, HOF factors must be considered in the decommissioning plans. ENSI attaches value to HOF factors, especially in decommissioning.
Stakeholder participation and knowledge management	During the preparation of the decommissioning of the Mühleberg NPP, the Swiss Confederation established an inter-institutional monitoring group. All stakeholders are member of this group: the Federal Office of Energy, the Federal Office for the Environment, the State of Bern, ENSI and BKW. There are three subgroups on technical aspects, legal procedure and communication. In March 2015, the subgroup of communication organised three public events around the Mühleberg NPP. In total more than 800 people visited these events and were very interested in the decommissioning plan, the funding, the costs, the waste treatment and disposal. There were hardly any critical voices to be heard.

Topical Session (2015): Extended and Deferred Decommissioning'	The Swiss regulatory system prefers immediate dismantling as decommissioning strategy, although deferred dismantling is not forbidden and is still an option for the licensees. According to the decommissioning plans (updated 2011, next update 2016), all operators plan to dismantle their facilities immediately. Also the funding system is based on this assumption. Only some unforeseen events could lead to a change in strategy in Switzerland. Because all NPP's are located in densely populated areas, the neighbours would not accept a deferred decommissioning. There is an exception: the VVA at PSI ceased operation in 2002, decommissioning starts in 2016. There was a period of care and maintenance mainly to secure the financing and to decrease the radiation levels in the plant.

16th Meeting of the Working Party on Decommissioning and Dismantling (WPDD) on 23-25 November

Country Update on Decommissioning

(Agenda Item #12b)

Country: USA –Commercial Decommissioning Status

Presenter: Boby Eid

Strategic Areas	Issues
Policy, regulation and strategy	**Policy:** decommission facilities after cease of operation safely to protect public health and safety and the environment using either unrestricted release (greenfield) or restricted release. **Regulations:** License Termination Rule under 10 CFR Part 20 Subpart E, 10 CFR Part 20 for radiation protection; and 10 CFR Part 50 specific regulations for Nuclear Power Reactors. In general risk/dose criteria of 0.25 mSv to average member of the critical group using all pathways including groundwater and a performance period of 1000 yr. **Strategy:** Current approach is to use two main decommissioning strategies namely "DECON" (immediate dismantling and decommissioning) and "SAFSTOR" (deferred decommissioning to terminate license after 60 years of cease of operation). Licensee could select either approach based on specific conditions and own priority and financial status. Commission requested staff to assess current approaches for decommissioning of nuclear power reactors in terms of: Granting exemptions for emergency and inspections after shut down, timeframe for decommissioning using 60 yr Safestor strategy, transitioning into decommissioning after shutdown, and regulatory approval of PSDAR report.
Funding and costs	Financial assurance mechanism in place and review of decommissioning funds biannually.
Techniques and Innovation	Segmentation advanced techniques; remote and robotic technology; biotechnology for remediation, revised survey, characterization, and sampling using non-parametric statistics, and guidance, updated risk/dose models, evaluation of remediation technologies, and technical basis for site-specific analysis of decommissioning waste disposal.
Materials management and site release	As of September 30, 2015, 19 nuclear power and early demonstration reactors, 5 research and test reactors, 15 complex materials facilities, 2 fuel cycle facilities, and 11 Title II uranium recovery facilities are undergoing decommissioning or are in long-term safe storage, under NRC jurisdiction. Each year, the NRC terminates approximately 125 materials licenses. Most of these license terminations are routine, and the sites require little, if any, remediation to meet the NRC's unrestricted release criteria. In FY 2015, the NRC terminated licenses for two research reactors at the University of Michigan and Worcester Polytechnic Institute. The NRC also completed site closure at the AAR site in Livonia, Michigan. In FY 2016, the NRC expects two to three complex materials sites to complete decommissioning activities, with similar numbers completing decommissioning in subsequent years. Most power reactors undergoing decommissioning will remain in SAFSTOR, with Zion Units 1 and 2, Humboldt Bay, and San Onofre Units 2 and 3 in active decommissioning. Progress in research and test reactor decommissioning will also continue as two or

	three more sites are expected to complete decommissioning in FY 2016. Within the next several years, several Title II[1] uranium recovery sites are expected to complete decommissioning and be transferred to the U.S. Department of Energy (DOE) for long-term control under a general license.
Human and organisational factors	Staff within the Office of Nuclear Material Safety and Safeguards (NMSS), the Regional offices, as well as the Office of Nuclear Reactor Regulation (NRR), the Office of Nuclear Security and Incident Response (NSIR), and the Office of the General Counsel (OGC) will continue to coordinate extensively on activities that support the transition of operating reactors to plants in a decommissioning status.
Stakeholder participation and knowledge management	Stakeholders are involved in development of decommissioning regulations and guidance document. They ate also involved via public meetings to discuss PSDAR, license termination plans, and the license termination process before its termination. They are also involved in the environmental impact assessment and decommissioning funding status. Currently, the public is involved by making comments on recently announced ANPR regarding transitioning into decommissioning of nuclear power reactors.
Topical Session (2015): Extended and Deferred Decommissioning'	NPPs have the two options for immediate (Decon) or deferred (Safstor) decommissioning options based on specific conditions and available funds. NRC staff delivered a presentation of the Pros & Cons of "Decon" vs Safstor."

[1] The Uranium Mill Tailings Radiation Control Act of 1978, as amended, classifies certain facilities that mill or process certain radioactive material as: Title I, which refers to those facilities that were inactive, unregulated processing sites when the act was passed; or Title II, which refers to those facilities licensed by the NRC or an Agreement State. Section 2.4, *infra*, explains this in detail.

附件三

核能研究所研究用反應器除役經驗與化學除污技術簡報

Chemical Decontamination Technologies Preparation for the Decommissioning of Taiwan Research Reactor

Tsong-Yang Wei

16th WPDD /CPD-MB-34 Meeting, Joint Special Session

Paris, 2015/11/25

Content

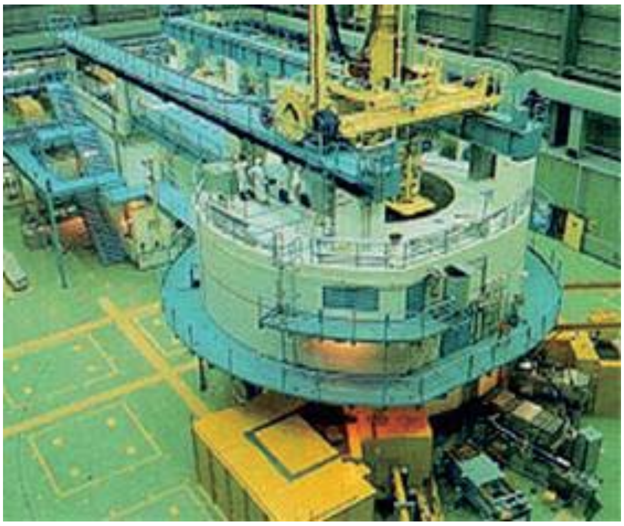
1. Status of Taiwan Research Reactor(TRR)
2. What chemical decontamination technologies are needed for the decommissioning of TRR.
3. Development of the needed chemical decontamination technologies.
4. Application of the developed chemical decontamination technologies
5. Lesson learned from experiences

1.Status of Taiwan Research Reactor (TRR)

1.TRR was a heavy water reactor. It was constructed in **1969**, and stopped running in **1988**.

2.INER planned to construct TRR-II in place of the TRR in **1998** at the same site. INER started to dismantle the non-essential auxiliary systems of the rector. However , the TRR-II project was cut off in **2002** due to the concern of the economic issue. The decommissioning of TRR is kept on going and shall be implemented not later than **2028** .

1.Status of Taiwan Research Reactor (TRR)



TRR was in operation before 1988

TRR was stopped running and executed one piece removal operation

2.What chemical decontamination technologies are needed for the decommissioning of TRR

1.The decommissioning of TRR will generate about **1100** tons of dismantled metal.

2.Metal waste is considered to be reduced through the **decontamination method**.

3.**Free release** is an important target as the mass activity of the dismantled metal is below 0.1 Bq/g.

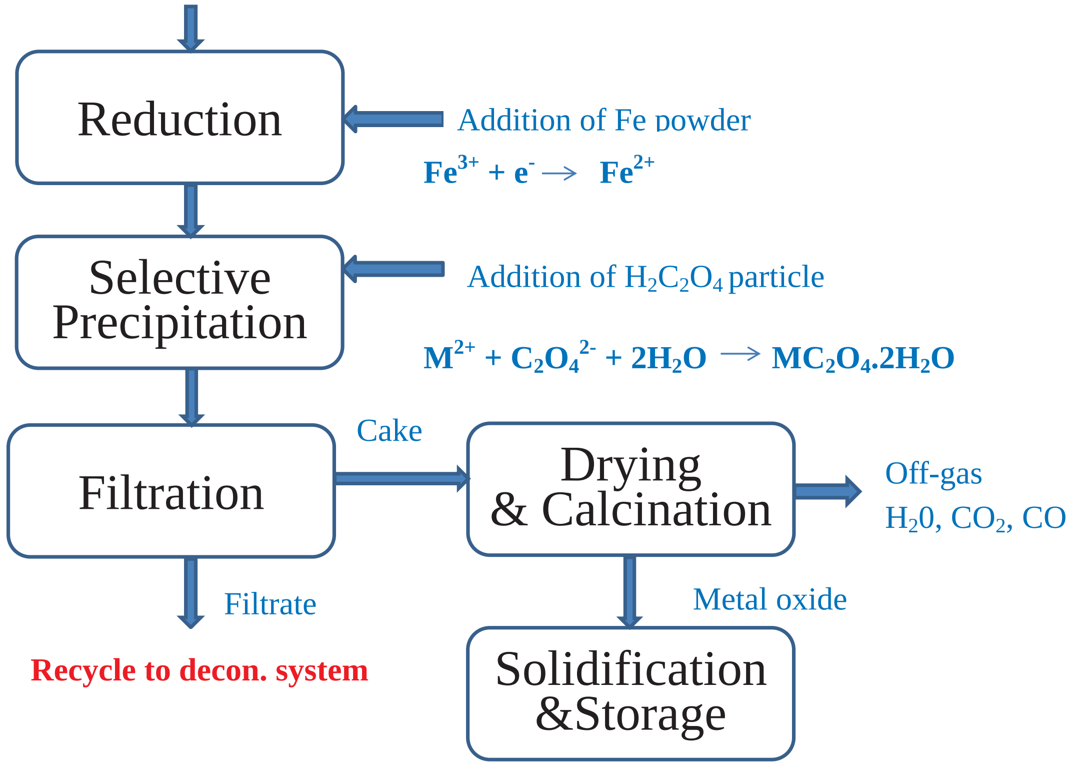
4.With the aid of mechanical decontamination methods, **a chemical decontamination method to remove a layer of the contaminated metal in short time and with less secondary waste is required for the purpose of radioactive waste reduction by free release.**

3. Development of the needed chemical decontamination technologies---process development

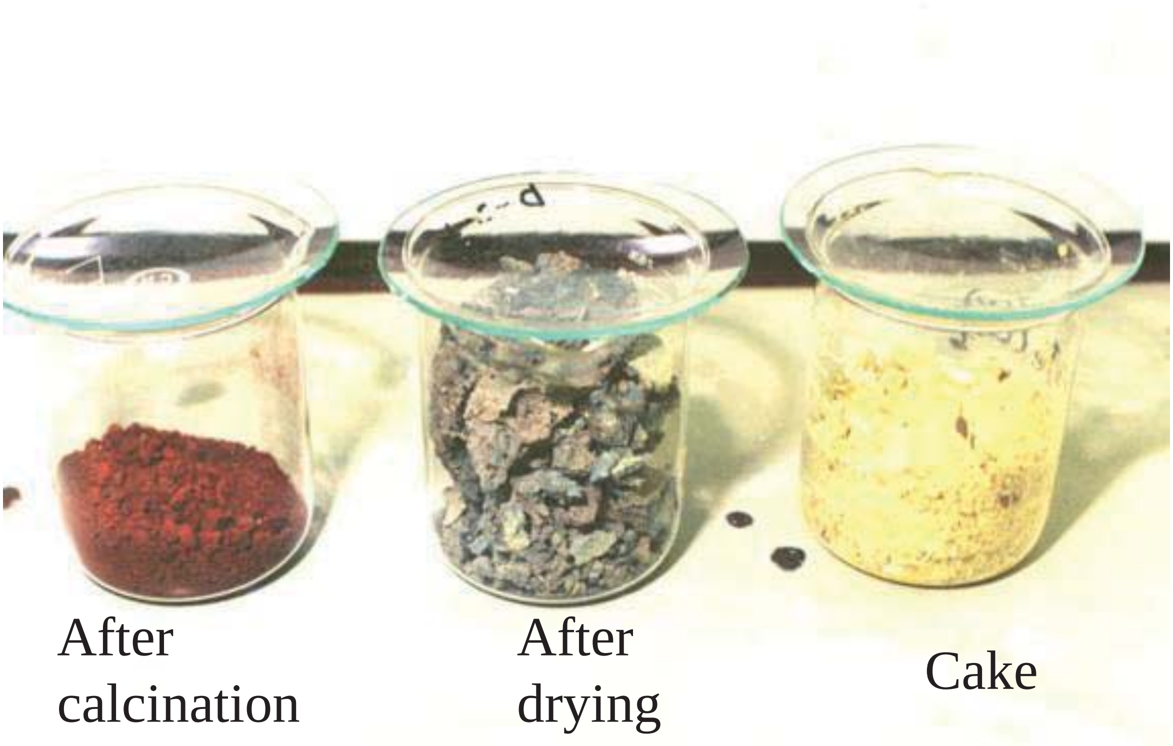
Main Agent	Comp.	Opera. Temp.	Opera. Time	Metal Dissolution Rate	Decon. Factor (DF)	Regeneration and 2nd Waste Treatment	Appl. Target
Oxalic Acid	1.H_2CO_4 2.Mineral Acid 3.Oxidant	90~100°C	1~6 hours	S. S. :0~3µm/h C. S. :0.5µm/min	2.5~1000	No regeneration. 2nd waste can be effectively treated by AOP method.	System decontamina-tion for piping system
Phosphoric Acid	1.H_3PO_4 2.Mineral Acid 3.Oxidant	70~80 °C	1~10 mins	S. S.: 0.5~1.5µm/h C. S.: ＞145µm/min Cu & Al: 0.5~9µm/min	3~1000	Regeneration with oxalic acid selective precipitation method. 2nd waste can be solidified by cement effectively (INER patent)	Dismantled Cu, Al, C.S.
Fluoboric Acid	1.HBF_4 2.Mineral Acid 3.Oxidant	70~80 °C	1~10 mins	S. S. : 5~60µm/h C. S.: ＞10µm/min Cu & Al: 25~40µm/min Ti: 50µm/min	3~1000	Regeneration with oxalic acid selective precipitation method. 2nd waste can be solidified with the phosphoric acid waste together by cement effectively (INER patent)	Dismantled S.S. and C.S.

3. Development of the needed chemical decontamination technologies –Decontaminant recycling

Spent H_3PO_4 solution or HBF_4 solution
(Be consisted of Fe, Cr, Ni, Co, Mn et. al. ions)

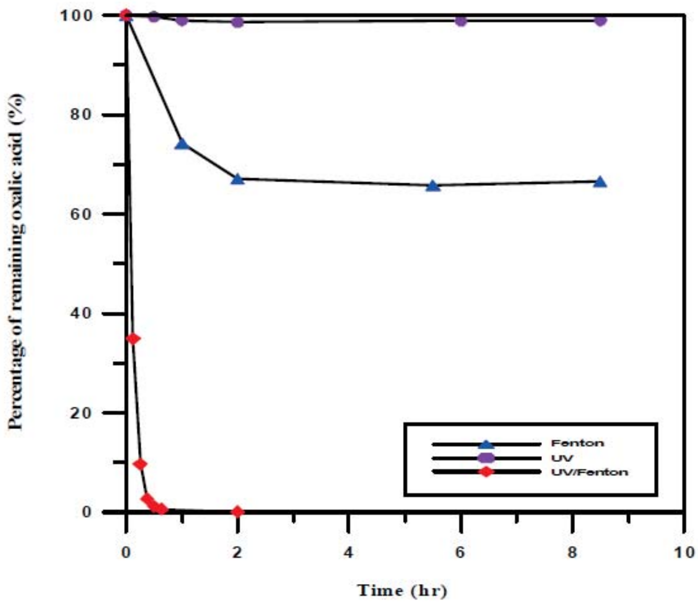


3. Development of the needed chemical decontamination technologies –2nd waste volume reduction



Institute of Nuclear Energy Research , Atomic Energy Council, Executive Yuan

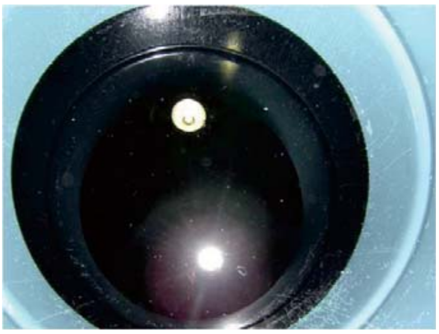
3. Development of the needed chemical decontamination technologies ---spent decontaminant treatment



Spent oxalic acid solution can be destructed by advanced oxidation method

3. Development of the needed chemical decontamination technologies ---spent decontaminant treatment

A high-efficiency solidification method has been developed and used to treat the spent phosphoric acid and fluoroboric acid solution in INER. The **self-polymerization nature** of highly concentrated phosphoric acid is adopted to immobilize the radioactive nuclides. The volume of solidified form is almost equal to that of the treated acid solution.



Spent decontaminant

After stabilization with cement

4. Application of the developed chemical decontamination technologies —to clean heat exchanger

Before

Clean heat exchange with a circulation system

After

4. Application of the developed chemical decontamination technologies— to clean heat exchanger

Heat exchanger specification	Operation Condition	Decontamination Efficiency			
		Surface Radiation Rate (Before), μSv/h	Surface Radiation Rate (After), μSv/h	Smear Activity (before), dpm/100 cm^2	Smear Activity (After), dpm/100 cm^2
1.Thermal shielding cooling system HX 2. Material: **C.S**. 3. Contaminated area: Shell side 4. Dimension: 145"(L) x 20" (Φ)	1. Oxalic acid solution 2. Temp. : 90~100℃ 3. Operation time: 6 hrs (3hrs/cycle)	**3~4**	**0.3~0.8 (Background value of the working house)**	**484**	**130**
1. Heavy water cooling system HX 2. Material: **S.S**. 3. Contaminated area: tube side 4. Dimension: 235"(L) x 20" (Φ)	1.Oxalic acid solution with mineral acid 2. Temp. : 90~100℃ 3. Operation time: 8 hrs (3hrs/cycle)	**0.8~12**	**0.3~0.8 (Background value of the working house)**	**5339**	**145**

4. Application of the developed chemical decontamination technologies— to clean metal scraps

Transferring basket

Chemical decontamination operating line

After decontamination

On-line activity measurement

Regeneration and effluent pretreatment

4. Application of the developed chemical decontamination technologies— to clean metal scraps

In the period of 2005~2008, 210 tons of metal scrap was cleaned with the decontamination facility in INER, 180 tons was successfully free release.

The Q2 system for clearance identification

5. Lesson learned from experiences

1. Most of the dismantled equipment is metal scrap, it is feasible to reduced the radioactive waste with a suitable chemical decontamination process.
2. For the practical application, the chemical decontaminants used for dismantled metal scraps cleaning, it must be recyclable and the spent solutions shall be stabilized efficiently.
3. Free release is an important measure for the radioactive waste reduction. However, it is always concerned by the environmental activists. Sufficient communication is requested to make the social and political climate change.

Thanks for your attention